

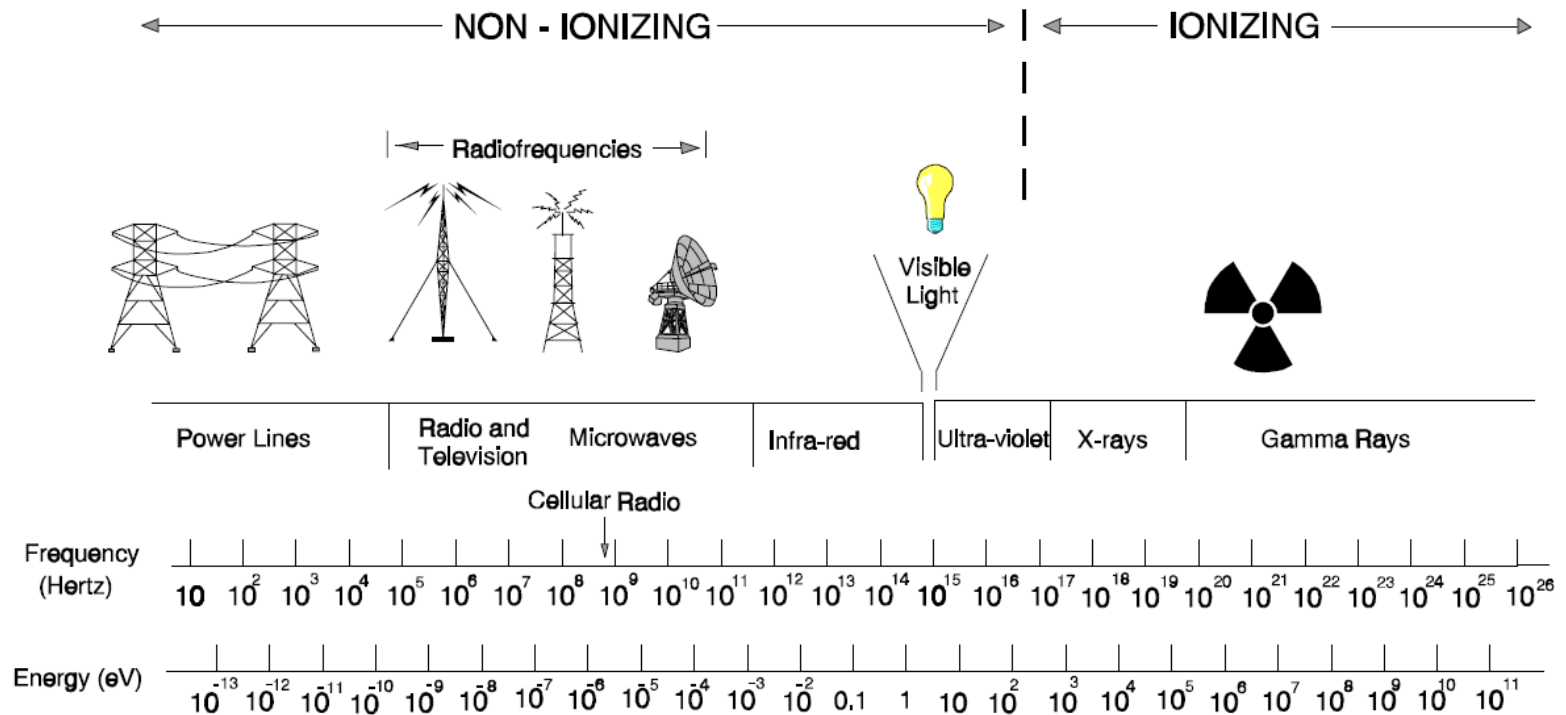
Geislunarhætta í tíðnisviðum radióamatöra

Fundur hjá ÍRA 08.desember 2011

Dagskrá

- ▶ Fjarskiptalög 81/2003
- ▶ Reglugerð 1047/2011 um skipulag og úthlutun tíðna í fjarskiptum
- ▶ Reglugerð um starfsemi radióáhugamanna 384/2010
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 - Verkaskipting PFS og Geislavarna ríkisins
 - Tilmæli ITU – alþjóðafjarskiptasambandið K.52 ofl.
 - Dæmi –USA Radióáhugamenn
 - Forrit fyrir útreikninga
 - K.70 frá ITU
 - ICNIRP fyrir radióáhugamenn

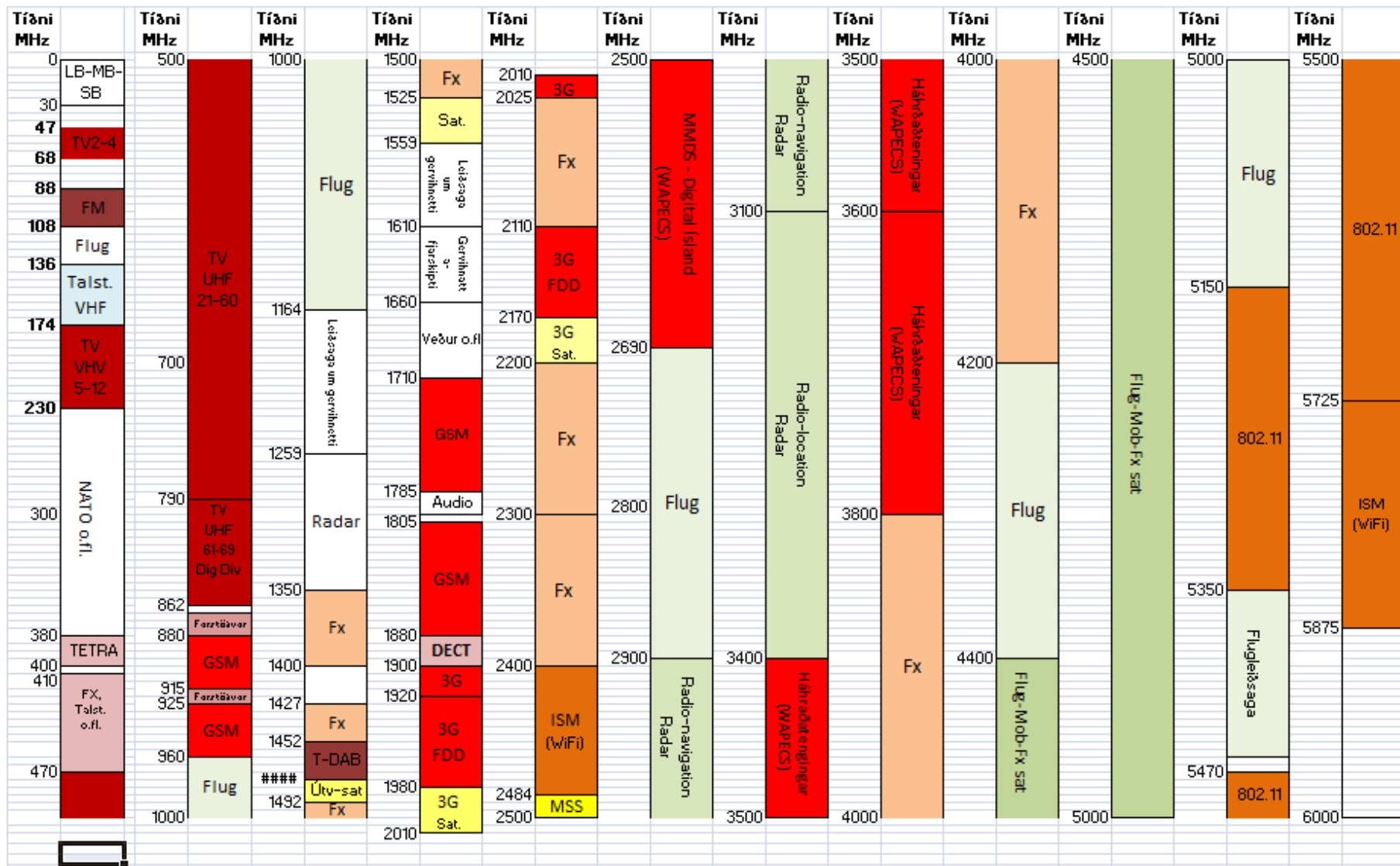
Radiation Spectrum



Gróft tíðniskipulag, 30 – 6000 MHz.

Notkun tíðnisviðsins 30 - 6000 MHz

(Almenn fjarskipta- og útvarpsþjónusta auðkennd sérstaklega með litum)



Lög nr. 81 / 2003

- ▶ **6.gr. *Skilyrði almennrar heimildar.***
 - l. um ráðstafanir til að takmarka áhættu almennings af rafsegulsviðum sem stafar frá fjarskiptanetum
 - n. um að viðhalda heildstæði almennra fjarskiptaneta, þ.m.t. skilyrði um að koma í veg fyrir rafsegultruflanir milli fjarskiptaneta eða þjónustu
- ▶ **10. gr. *Skilyrði um notkun tíðna og númera.***
 - c. að búnaður og rekstur fjarskiptafyrirtækis geri skaðlegar truflanir og rafsegulgeislun sem almenningur getur orðið fyrir sem minnstar
- ▶ **61. gr. *Notendabúnaður og tæki fyrir þráðlaus fjarskipti.***

Póst- og fjarskiptastofnun hefur eftirlit með sölu notendabúnaðar fyrir fjarskipti og tækja fyrir þráðlaus fjarskipti. Eftirfarandi grunnkröfur eiga við um öll slík tæki:

 1. Um verndun heilsu og öryggis notanda jafnt og annarra manna.
 2. Um að tæki í notkun hafi ekki truflandi áhrif á rafsegulumhverfið

68. gr. *Heimildir til starfrækslu þráðlauss búnaðar.*

- ▶ Póst- og fjarskiptastofnun gefur út skírteini sem heimila einstaklingum að starfrækja ákveðnar tegundir þráðlauss búnaðar.
[Ekki er gerð krafa um sérstaka þjálfun þeirra sem starfrækja þráðlausan búnað nema í þeim tilfellum að búnaðurinn gegni öryggishlutverki eða þegar sendiafl er umfram 100 W. Heimilt er að gefa út skírteini talstöðvavarðar sem heimilar handhafa að starfrækja fjarskiptabúnað í skipum. Ráðherra er heimilt að kveða nánar á um útgáfu skírteinis talstöðvavarðar og hæfniskröfur í reglugerð.]¹⁾
- ▶ Póst- og fjarskiptastofnun gefur út leyfi til radióáhugamanna að fengnum umsóknum þeirra og umsögn hagsmunasamtaka áhugamanna. Erlendir ríkisborgarar geta sótt um leyfi til bráðabirgða eða til lengri tíma. [Ráðherra]²⁾ setur reglugerð³⁾ um starfsemi radióáhugamanna

Reglugerð nr 1047/2011 um skipulag og úthlutun tíðna í fjarskiptum

6. gr. *Alþjóðleg ráðstöfun tíðna til tiltekinna nota.*

- ▶ Tíðnisviðum sem á alþjóða tíðniráðstefnum er ráðstafað til tiltekinna notkunar, sem í eðli sínu er alþjóðleg og ekki bundin við einstök ríki, t.d. fjarskipti við flugvélar og skip, flugöryggis- og leiðsöguþjónustu, fjarskipti radióáhugamanna o.s.frv. er óheimilt að úthluta til annarra nota á Íslandi.

34. gr. *Ráðstafanir vegna rafsegulgeislunar– Reglugerð*

- ▶ Tíðnirétthafi skal gera ráðstafanir til að halda í lágmarki áhættu almennings af rafsegulgeislun sem stafar frá radióbúnaði. Leitast skal við að staðsetja fjarskiptavirki þar sem almenningur verður fyrir sem minnstum áhrifum af slíkri geislun.
- ▶ Tíðnirétthafi skal fara eftir fyrirmælum og reglum sem stjórnvöld kunna að setja um rafsegulgeislun, þ.m.t. að fylgt sé ákveðnum stöðlum.
- ▶ Ef í ljós kemur að rafsegulgeislun frá fjarskiptavirkjum er yfir viðmiðunarmörkum í reglum eða viðeigandi stöðlum skal fyrirtækið bæta úr því án tafar eða að öðrum kosti hætta notkun viðkomandi fjarskiptavirkis.
- ▶ Ef samanlögð rafsegulgeislun frá fjarskiptavirkjum sem staðsett eru nálægt hvort öðru fer yfir viðmiðunarmörk, án þess að nokkur einstakur búnaður fari yfir mörkin, skal það fyrirtæki sem síðast setti upp búnað bæta úr ástandinu eða hætta notkun hans.

Reglugerð um starfsemi ráðióáhugamanna 384/2010

► *Ráðióáhugamannabjónusta:*

Þráðlaus fjarskiptabjónusta sem hefur að tilgangi eigin þjálfun, samskipti á ljósvakanum og tæknilegar athuganir sem ráðióáhugamenn annast, þ.e. einstaklingar sem fengið hafa til þess heimild. Bjónustan er eingöngu í þágu einstaklinga og má ekki nota til fjárhagslegs ávinnings.

6. gr.

Lagnir og tækjabúnaður

- ▶ Radíóáhugamenn skulu ganga úr skugga um að allar lagnir sem tengja búnað þeirra við rafmagnsnetið, svo og búnaðurinn sjálfur, samræmist opinberum reglum um raforkuvirki. Spenna á rásum í heimasmiðuðum búnaði N-leyfishafa skal ekki vera hærri en 50 volt.
- ▶ Allur sendibúnaður leyfishafa skal hafa tíðnistöðugleika í samræmi við kröfur alþjóðaradíóreglugerðarinnar. Óæskileg útgeislun skal einnig vera takmörkuð við ákvæði alþjóðaradíóreglugerðarinnar.

12. gr.

Aðstoð við eftirlit.

- ▶ Rádíóáhugamenn skulu eftir mætti aðstoða eftirlitsmenn Póst- og fjarskiptastofnunar við leit að truflunum sem taldar eru stafa frá stöðvum rádíóáhugamanna, m.a. með því að aðstoða við miðun á truflanavaldi. Slík aðstoð skal vera endurgjaldslaus nema um annað hafi verið samið fyrirfram.

13. gr.

Aðgangur eftirlitsmanna

- ▶ Eftirlitsmönnum Póst- og fjarskiptastofnunar skal heimilaður aðgangur að búnaði radió-áhugamanna sem fellur undir ákvæði þessarar reglugerðar í því skyni að kanna hvort hann samræmist reglugerðinni. Leiki á grunur um að búnaður radióáhugamanns valdi truflunum á annarri fjarskiptastarfsemi skal hann veita eftirlitsmönnum Póst- og fjarskiptastofnunar aðstoð við að stöðva truflanirnar.

14. gr.

Niðurfelling leyfa.

- ▶ Póst- og fjarskiptastofnun er heimilt að undangenginni rannsókn að fella leyfi radió-áhugamanns úr gildi ef um alvarlegt brot á ákvæðum leyfisbréfs, laga um fjarskipti eða þessarar reglugerðar er að ræða.

Tíðnistefna PFS

► 6.11 Radíóáhugamannaþjónusta

Þjónusta fyrir radíóáhugamenn (radíóamatöra) er viðurkennd af hálfu ITU með formlegri þjónustuskilgreiningu í fjarskiptareglum og sérstaklega úthlutuðu tíðnisviði fyrir þá.

Það er mat PFS að auka þurfi fræðslu og eftirlit með þessari þjónustu og meta hvort ástæða sé til að endurskoða hámarkssendistyrk sem leyfður er í þéttbýli. Þá verður metið hvort ástæða er til að gera kröfur um tiltekna lágmarksfjarlægð loftnets frá íbúðarhúsnæði m.t.t. alþjóðlegra viðmiða

REGLUGERÐ um starfsemi rádíóáhugamanna 348/2004

- ▶ 4.gr
- ▶ Póst- og fjarskiptastofnun getur sett takmarkanir á stefnumögnun loftneta eða útgeislað afl ef ljóst er að hætta sé á að annar fjarskiptabúnaður, þ.m.t. útvarpsviðtæki, yfirstýrist af sendingu radíóáhugamanns. Einnig getur stofnunin sett takmarkanir á útgeislað afl ef sýnt þykir að heilsu manna geti stafað hætta af útgeisluðu afli.

VIÐAUKI

Tíðnisvið radióáhugamanna, sendiafl og bandbreidd.

Tíðnisvið	Forgangs-flokkur	N-leyfi	G-leyfi	Bandbreidd
135,7-137,8 kHz	2		100	1 kHz
1.810-1.850 kHz	1	100	1000	6 kHz
1.900-2.000 kHz	2	10	10	6 kHz
3.500-3.800 kHz	1	100	1000	6 kHz
7.000-7.100 kHz	1	100	1000	6 kHz
7.100-7.200 kHz	2	100	100	6 kHz
10.100-10.150 kHz	2	100	1000	1 kHz
14.000-14.350 kHz	1	100	1000	6 kHz
18.068-18.168 kHz	1	100	1000	6 kHz
21.000-21.450 kHz	1	100	1000	6 kHz
24.890-24.990 kHz	1	100	1000	6 kHz
28.000-29.700 kHz	1	100	1000	18 kHz
50-52 MHz	2	50	100	18 kHz
144 -146 MHz	1	50	500	18 kHz
430-440 MHz	1	50	500	30 kHz
1.240-1.300 MHz	2	50	100	20 MHz
2.300-2.450 MHz	2	50	100	20 MHz
5.650-5.850 MHz	2	50	100	20 MHz
10-10,5 GHz	2	50	100	50 MHz
24-24,05 GHz	1	50	100	50 MHz
24,05-24,25 GHz	2	50	100	50 MHz
47-47,2 GHz	1	50	100	50 MHz
76-77,5 GHz	2	50	100	100 MHz
77,5-78 GHz	1	50	100	100 MHz
78-81 GHz	2	50	100	100 MHz
122,25-123 GHz	2	50	100	40 MHz
134-136 GHz	1	50	100	100 MHz
136-141 GHz	2	50	100	100 MHz
241-248 GHz	2	50	100	100 MHz
248-250 GHz	1	50	100	100 MHz

Ath. Sendiaflið er toppgildi aflsins (PEP), þ.e. hæsta meðalafl sem sendirinn gefur frá sér á hverri períóðu RF-merkisins í 50/300/600 ohma endurkastslaust álag.

Rafsegulgeislun frá fjarskiptavirkjum

- ▶ Verkaskipting PFS og Geislavarna
- ▶ Geislavarnir Ríkisins
 - Mælingar
 - Meta hvort umhverfi og aðstæður séu með þeim hætti að mönnum sé hættu búin hvað þetta varðar.
- ▶ PFS
 - Takmarkanir á sendiafli ef þarf
 - Fræðsla

Alþjóðlegt

- ICNIRP, *Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic field (up to 300 GHz)*, 1998
 - Notað í mörgum löndum
 - Ef ekki er til sérstakarreglur um viðmið
 - European Commission hefur mælt með að ríkin noti ICNIRP sjá (1999/519/EEC)
 - <http://www.icnirp.de>
- ▶ ICNIRP : Notað af ITU

EMF Exposure Standards

- ▶ Dæmi erlendis

- USA

- FCC, 96-326, *Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation*

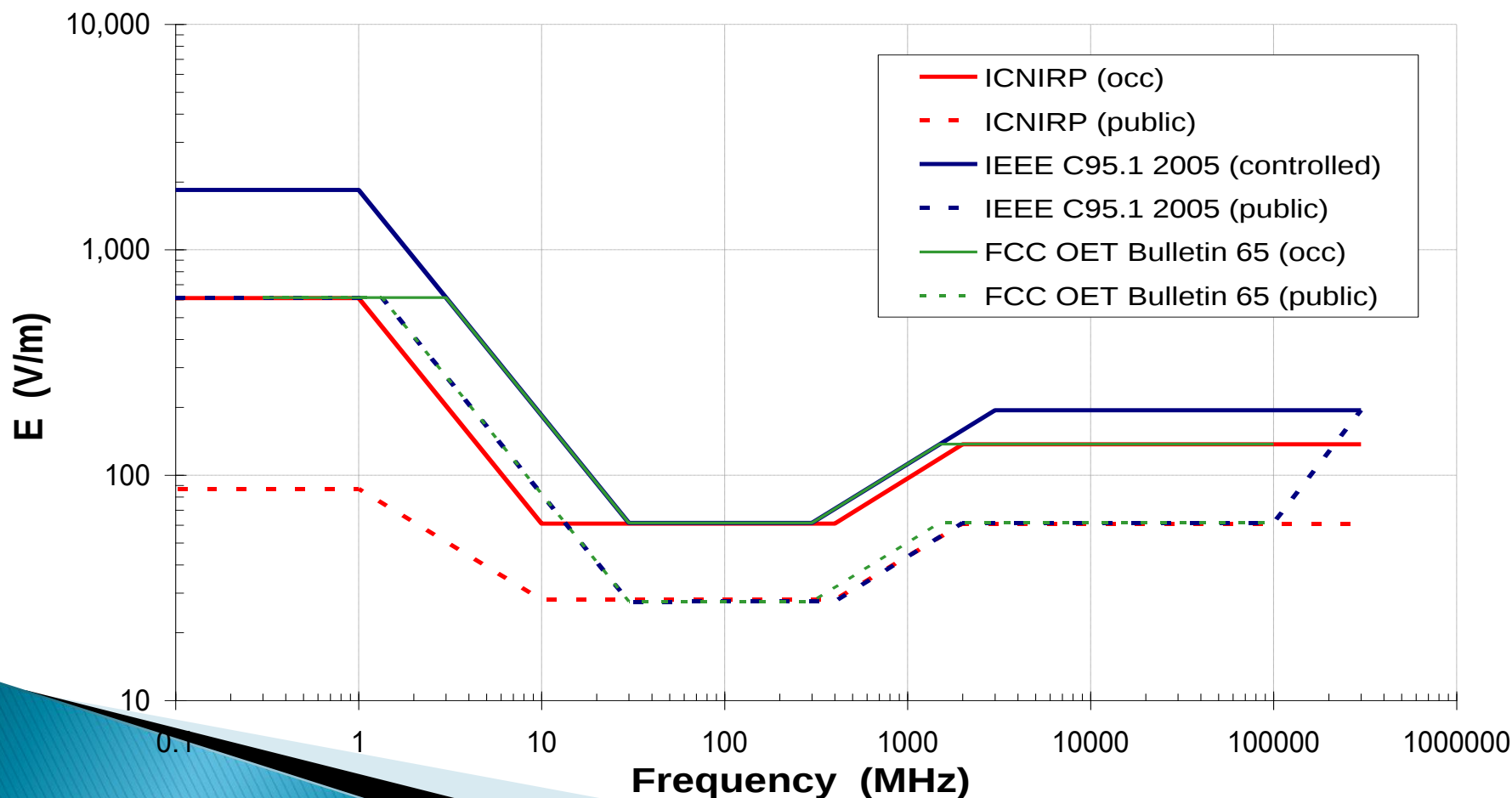
- ▶ *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*

- *Additional Information for Amateur Radio Stations*

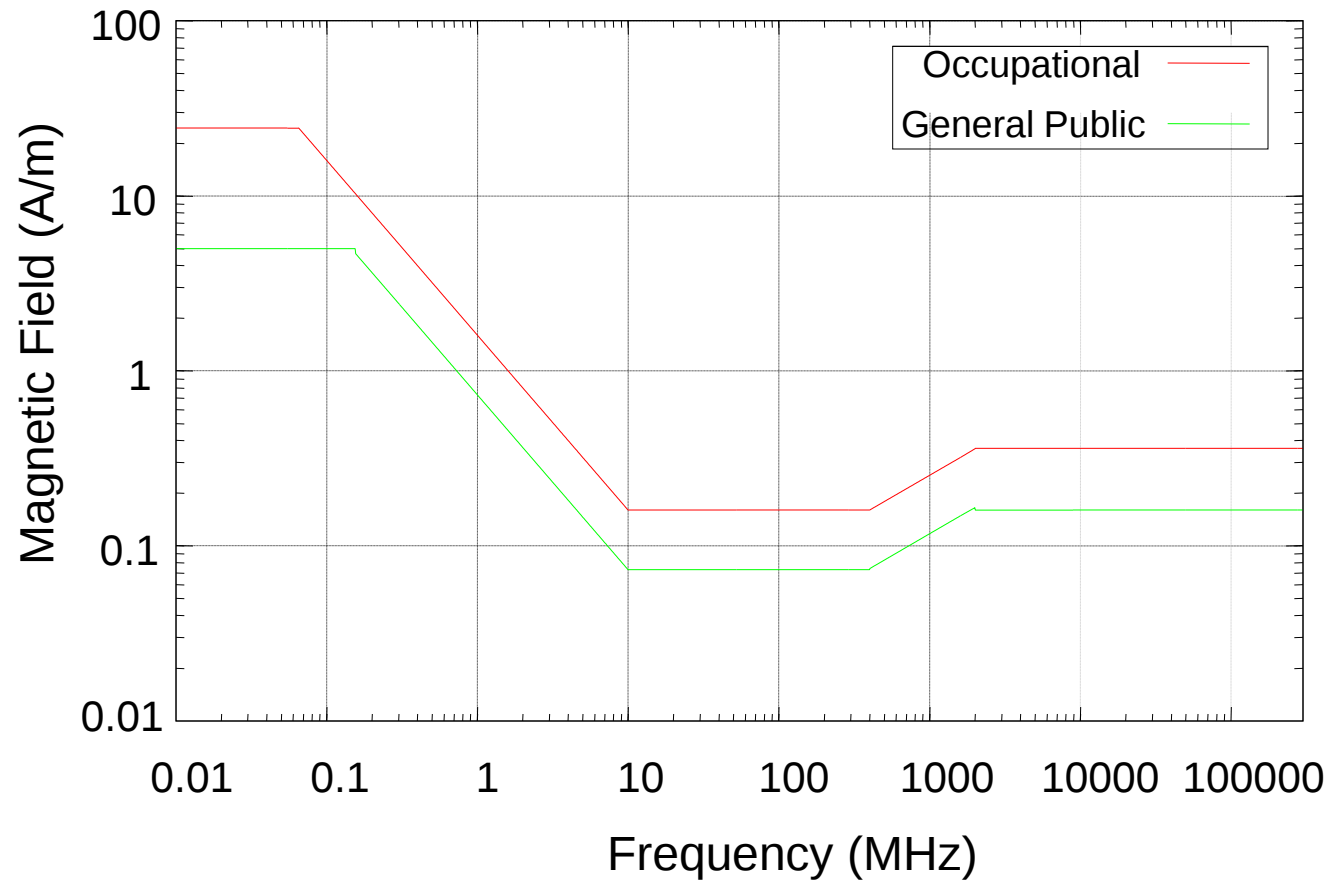
http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65b.pdf

Samanburður milli viðmiða ICNIRP og IEEE Standards

E-field limits



ICNIRP Reference Levels — Segul svið



Conversion of SAR to Power Density

Threshold for Hazard Specific Absorption Rate (SAR) = 4 Watts/kg

Applying a Safety Factor 10 (SAR) = 0.4 Watts/kg

CONVERTING to POWER DENSITY: for HUMAN EXPOSURE

Average Man or Woman

WEIGHT = 60 kg

SURFACE AREA = 20,000 cm²

PH = POWER DENSITY for SAFETY THRESHOLD

$$\begin{aligned} \text{PH} &= 0.4 \text{ Watts/kg} * \frac{60\text{kg}}{20,000\text{cm}^2} \\ &= 1.2 \text{ milli Watts}/(\text{cm})^2 \end{aligned}$$

Sérstaklega skoða

- ▶ Viðkvæm svæði líkamans
 - Tvö svæði líkamans, augun og eistum, eru sérstaklega viðkvæm fyrir RF hitan vegna lítils blóðflæðis.
- ▶ Börn
 - Lítil
 - Óvitar

ITU Recommendations – *de facto* Standards on

- ▶ spectrum management issues
- ▶ radiocommunication system characteristics and operation

ITU-T –Tilmæli related to human exposure to E.M. fields

ITU-T Recommendations K.52 and K.61

- guidance on complying with safety limits for human exposure to e.m. fields from a telecommunication installation or mobile handset
- adopts a step-by-step approach to determine an *exceedance zone* (within which field exceeds reference limits)
- compliance achieved if exceedance zone is not accessible to personnel under normal conditions

ITU-T Recommendation K.70

- Mitigation Techniques to limit human exposure to EM fields in the vicinity of radiocommunication stations
- Software provided that implements methodology

Mælingar

- ▶ Nauðsynlegt til að sannreyna
 - Veitir öryggi með útreikningum
- ▶ Í flóknum aðstæðum
 - Margir sendar
 - Jaðardæmi
- ▶ sjá ITU–T Recommendation K.61, *Guidance to measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations*

ITU Recommendations related to human exposure

E.M Radiation from a telecommunication installation

E.M. Safety Limits

**Recommendation ITU-R BS.1698
ITU-T Recommendation K.52
ITU-T Recommendation K.61**

ITU-T Recommendation K.70

Assessment of hazard and need for precautionary measures

Mitigation Techniques to limit human exposure

K.52

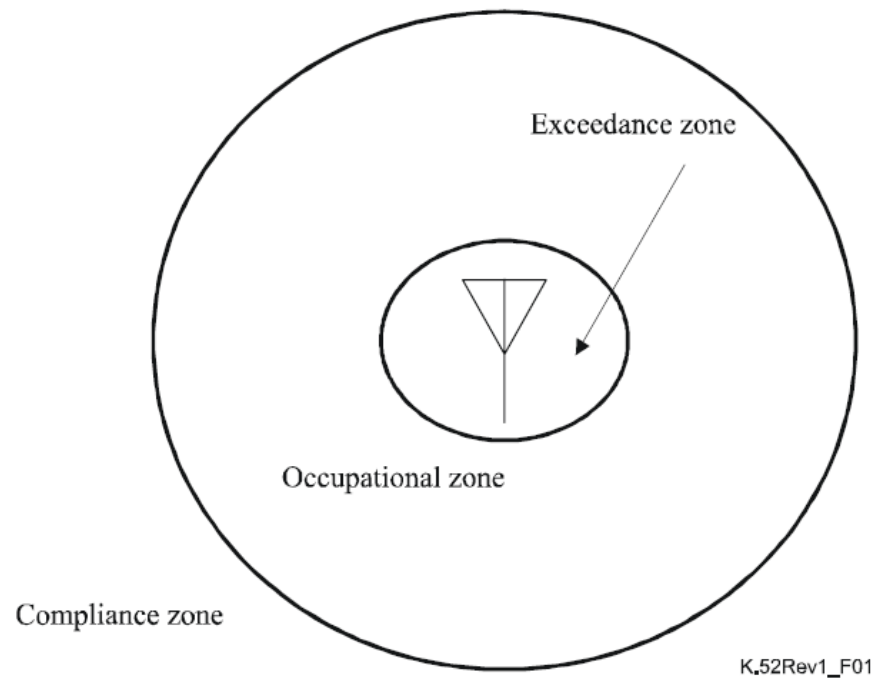
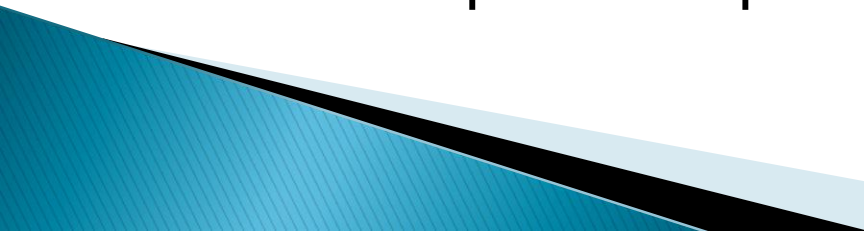
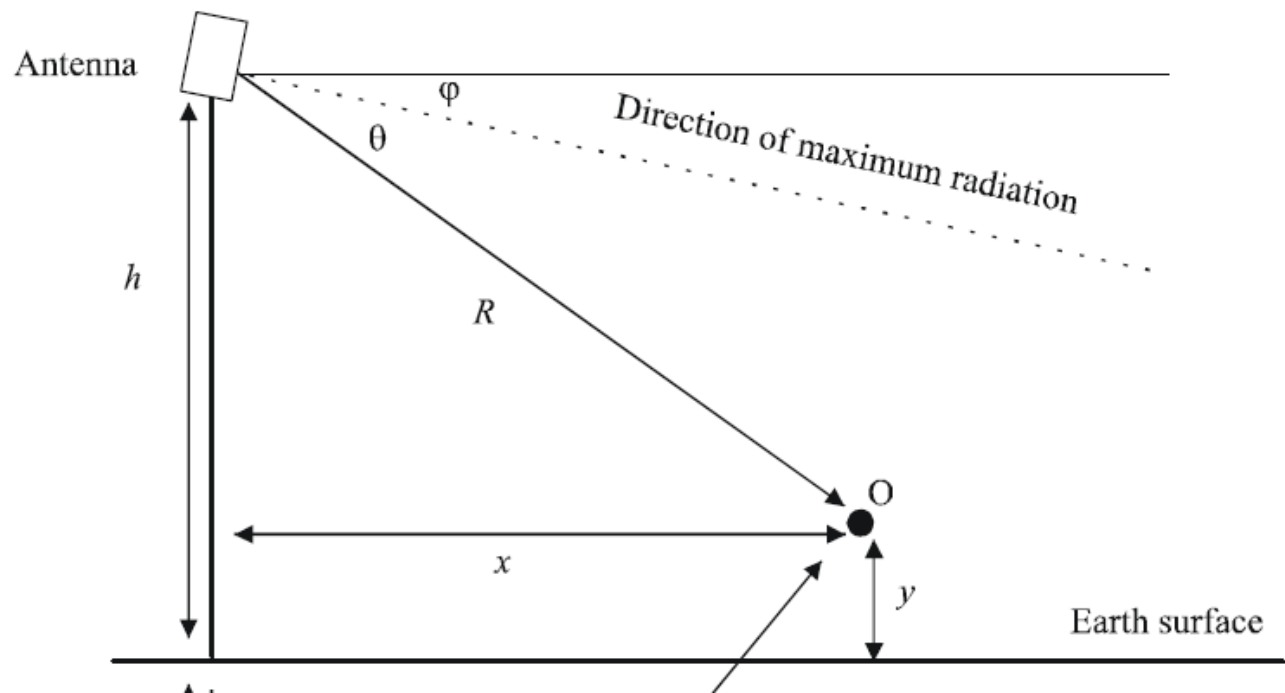


Figure 1/K.52 – Figurative illustration of exposure zones

K.52 Exposure Classification

- ▶ Compliance zone
 - Potential exposure to EMF is below the applicable limits
 - ▶ Occupational zone
 - Potential exposure to EMF is below the limits for occupational exposure but exceeds the limits for general public exposure
 - ▶ Zone where limit exceeded
 - Potential exposure to EMF exceeds the limits for both occupational and general public exposure
- 

K.52



K.52

f (MHz)	$S_{lim}(f)$ (W/m ²)	
	General public	Occupational
100-400	2	10
400-2 000	$f/200$	$f/40$
$2 \cdot 10^3$ - $300 \cdot 10^3$	10	50

K.52 1000 W sendir

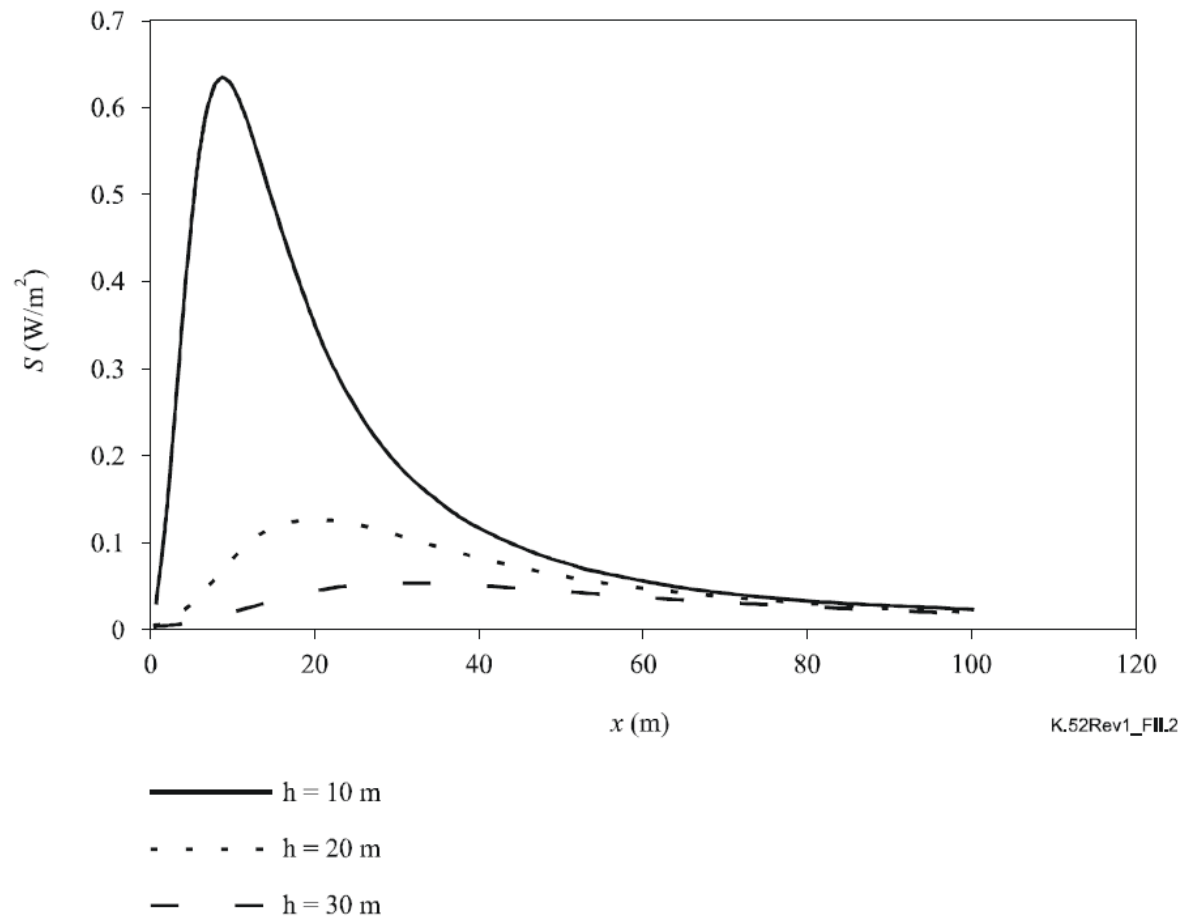
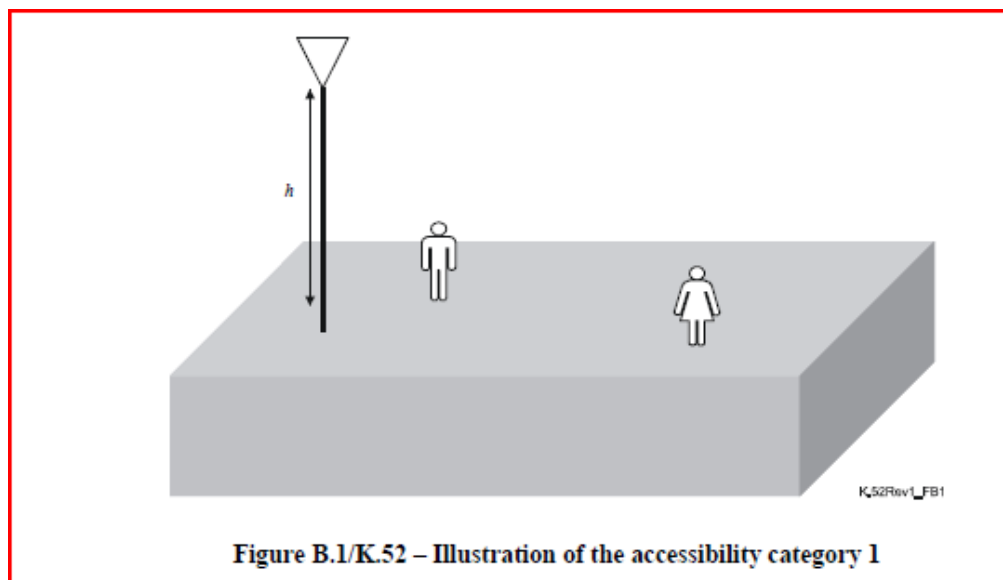


Figure II.2/K.52 – Power density at the ground level vs distance from the tower

Table B.1/K.52 – Accessibility categories

Accessibility category	Relevant installation circumstances	Figure reference
1	Antenna is installed on an inaccessible tower – the centre of radiation is at a height h above ground level. There is a constraint $h > 3$ m. Antenna is installed on a publicly accessible structure (such as a rooftop) – the centre of radiation is at a height h above the structure.	Figure B.1
2	Antenna is installed at ground level – the centre of radiation is at a height h above ground level. There is an adjacent building or structure accessible to the general public and of approximately height h located a distance d from the antenna along the direction of propagation. There is a constraint $h > 3$ m.	Figure B.2
3	Antenna is installed at ground level – the centre of radiation is at a height h ($h > 3$ m) above ground level. There is an adjacent building or structure accessible to the general public and of approximately height h' located at a distance d from the antenna along the direction of propagation.	Figure B.3
4	Antenna is installed on a structure at a height h ($h > 3$ m). There is an exclusion area associated with the antenna. Two geometries for the exclusion area are defined: – A circular area with radius a surrounding the antenna; or – A rectangular area of size $a \times b$ in front of the antenna.	Figure B.4 Figure B.5

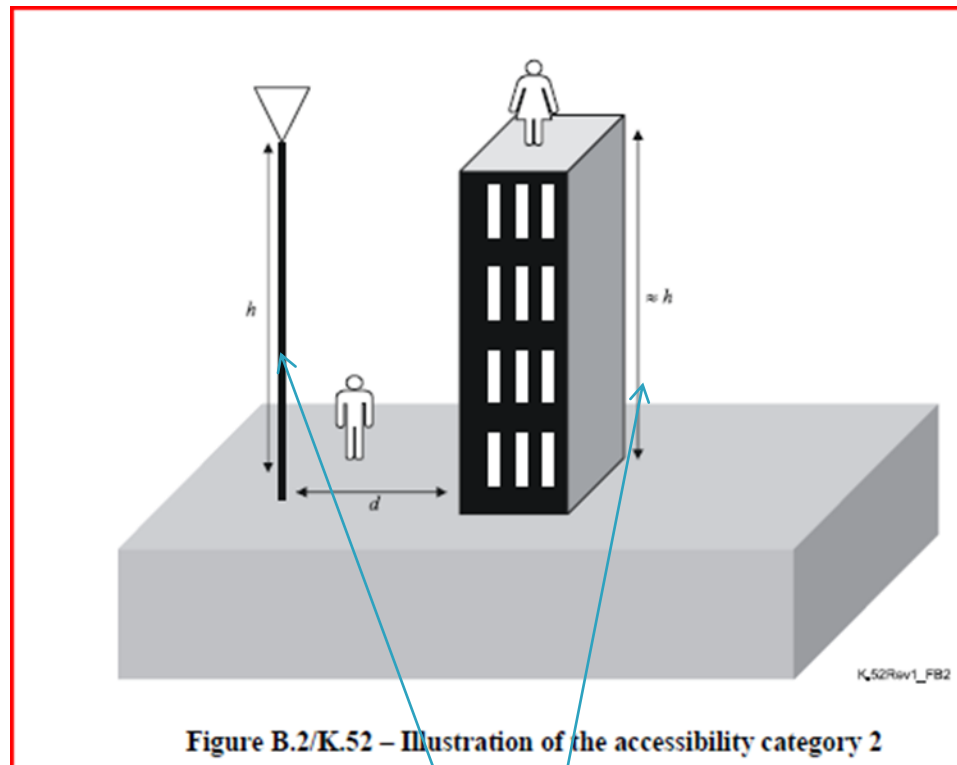
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2

Antenna is installed at ground level – the centre of radiation is at a height h above ground level. There is an adjacent building or structure accessible to the general public and of approximately height h located a distance d from the antenna along the direction of propagation. There is a constraint $h > 3$ m.

Figure B.2

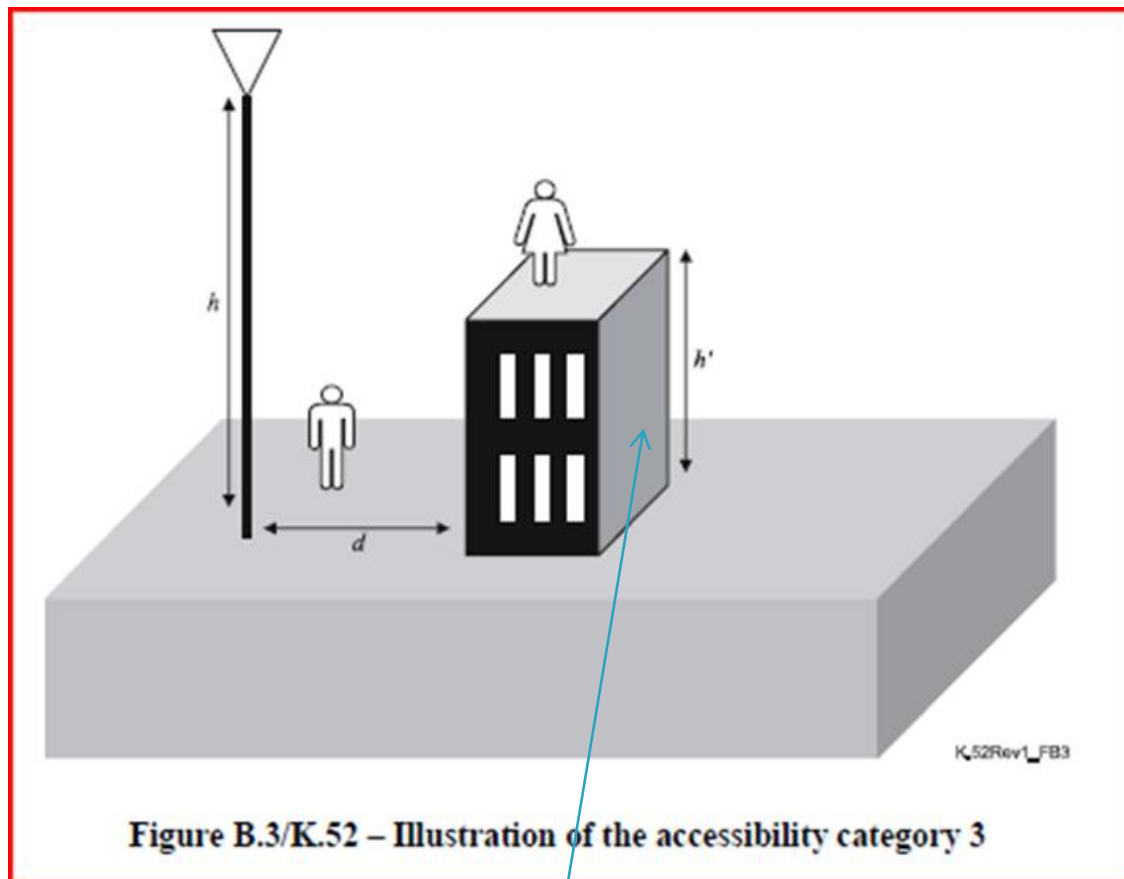


Sama hæð

3

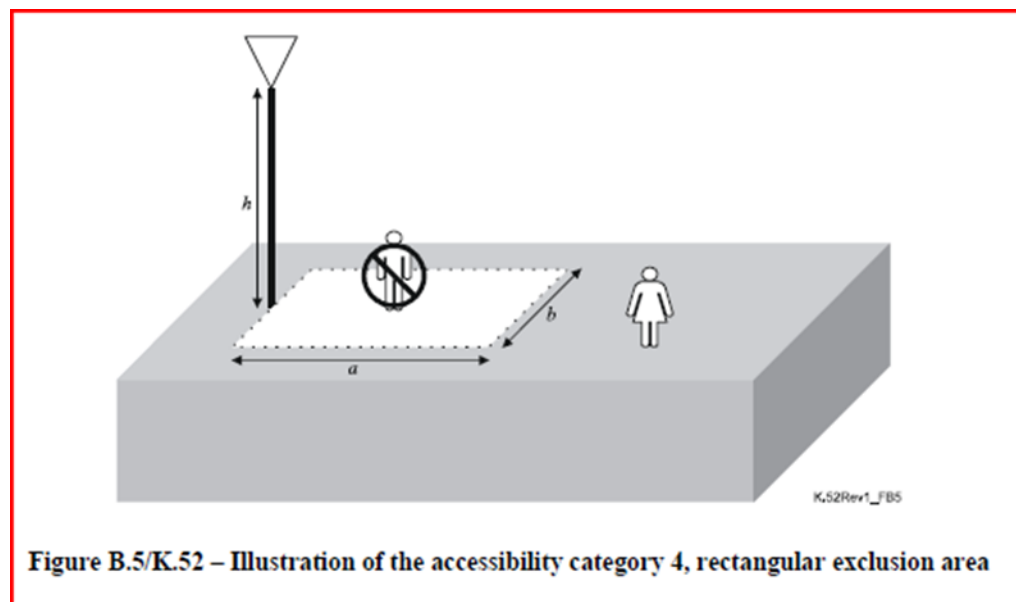
Antenna is installed at ground level – the centre of radiation is at a height h ($h > 3$ m) above ground level. There is an adjacent building or structure accessible to the general public and of approximately height h' located at a distance d from the antenna along the direction of propagation.

Figure B.3



Bygging er
minni

4	Antenna is installed on a structure at a height h ($h > 3$ m). There is an exclusion area associated with the antenna. Two geometries for the exclusion area are defined: – A circular area with radius a surrounding the antenna; or – A rectangular area of size $a \times b$ in front of the antenna.	Figure B.4 Figure B.5
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Bygging við hliðina

K.52

II.2 Exposure at an adjacent building

The geometry for calculating exposure at a building adjacent to an antenna tower is shown in Figure II.3.

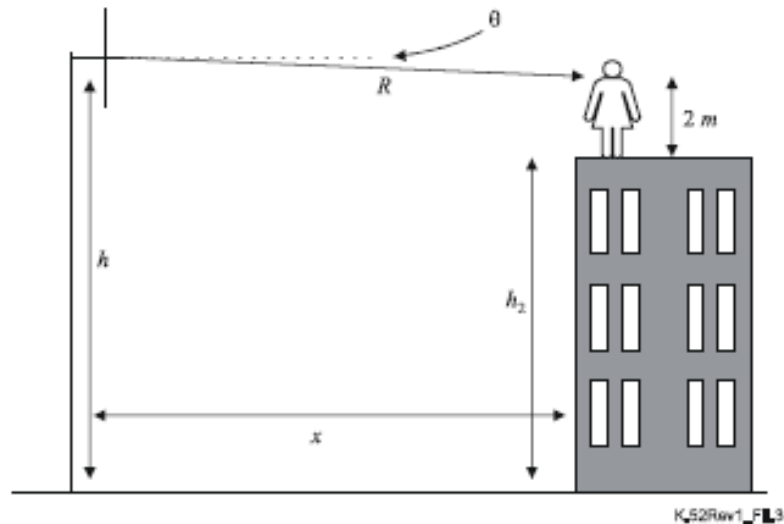


Figure II.3/K.52 – Sample configuration for calculating exposure at an adjacent building

Formúlur

Table C.1 – Expressions for the calculation of minimum distances to antennas of transmission stations for compliance with the exposure limits for the population in general

Radio frequency range	General public exposure	
1 to 10 MHz	$r = 0.10\sqrt{eirp \times f}$	$r = 0.129\sqrt{erp \times f}$
10 to 400 MHz	$r = 0.319\sqrt{eirp}$	$r = 0.409\sqrt{erp}$
400 to 2000 MHz	$r = 6.38\sqrt{eirp / f}$	$r = 8.16\sqrt{erp / f}$
2000 to 300000 MHz	$r = 0.143\sqrt{eirp}$	$r = 0.184\sqrt{erp}$
r is the minimum antenna distance, in metres f is the frequency, in MHz erp is the effective radiated power in the direction of the largest antenna gain, in Watts $eirp$ is the equivalent isotropically radiated power in the direction of the largest antenna gain, in Watts		

$$E(r) = \frac{\sqrt{30 * P_{EIRP}}}{r} \approx \frac{5,5}{r} * \sqrt{P_{EIRP}}$$

Dæmi um skilyrði fyrir radióáhugamenn

- ▶ USA: FCC

Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

- ▶ *Additional Information for Amateur Radio
Stations*

Table 4b. (VHF/UHF Bands)
(Developed by Fred Maia, WSYI Group, working in cooperation with the ARRL.)

Estimated distances in meters from transmitting antennas necessary to meet FCC power density limits for Maximum Permissible Exposure (MPE) for either occupational/ controlled exposures ("Con") or general population/uncontrolled exposures ("Unc") using typical antenna gains for the amateur service and assuming 100% duty cycle and maximum surface reflection. Chart represents worst case scenario.

Freq (VHF/UHF) (MHz/Band)	Antenna Gain (dBi)	Peak Envelope Power (watts)							
		50 watts		100 watts		500 watts		1000 watts	
		Con.	Unc.	Con.	Unc.	Con.	Unc.	Con.	Unc.
50 (6m)	0	1.0	2.3	1.4	3.2	3.2	7.1	4.5	10.1
50 (6m)	3	1.4	3.2	2.0	4.5	4.5	10.1	6.4	14.3
50 (6m)	6	2.0	4.5	2.8	6.4	6.4	14.2	9.0	20.1
50 (6m)	9	2.8	6.4	4.0	9.0	9.0	20.1	12.7	28.4
50 (6m)	12	4.0	9.0	5.7	12.7	12.7	28.4	18.0	40.2
50 (6m)	15	5.7	12.7	8.0	18.0	18.0	40.2	25.4	56.8
144 (2m)	0	1.0	2.3	1.4	3.2	3.2	7.1	4.5	10.1
144 (2m)	3	1.4	3.2	2.0	4.5	4.5	10.1	6.4	14.3
144 (2m)	6	2.0	4.5	2.8	6.4	6.4	14.2	9.0	20.1
144 (2m)	9	2.8	6.4	4.0	9.0	9.0	20.1	12.7	28.4
144 (2m)	12	4.0	9.0	5.7	12.7	12.7	28.4	18.0	40.2
144 (2m)	15	5.7	12.7	8.0	18.0	18.0	40.2	25.4	56.8
144 (2m)	20	10.1	22.6	14.3	32.0	32.0	71.4	45.1	101.0
222 (1.25m)	0	1.0	2.3	1.4	3.2	3.2	7.1	4.5	10.1
222 (1.25m)	3	1.4	3.2	2.0	4.5	4.5	10.1	6.4	14.3
222 (1.25m)	6	2.0	4.5	2.8	6.4	6.4	14.2	9.0	20.1
222 (1.25m)	9	2.8	6.4	4.0	9.0	9.0	20.1	12.7	28.4
222 (1.25m)	12	4.0	9.0	5.7	12.7	12.7	28.4	18.0	40.2
222 (1.25m)	15	5.7	12.7	8.0	18.0	18.0	40.2	25.4	56.8
450 (70cm)	0	0.8	1.8	1.2	2.6	2.6	5.8	3.7	8.2
450 (70cm)	3	1.2	2.6	1.6	3.7	3.7	8.2	5.2	11.6
450 (70cm)	6	1.6	3.7	2.3	5.2	5.2	11.6	7.4	16.4
450 (70cm)	9	2.3	5.2	3.3	7.3	7.3	16.4	10.4	23.2
450 (70cm)	12	3.3	7.3	4.6	10.4	10.4	23.2	14.7	32.8
902 (33cm)	0	0.6	1.3	0.8	1.8	1.8	4.1	2.6	5.8
902 (33cm)	3	0.8	1.8	1.2	2.6	2.6	5.8	3.7	8.2
902 (33cm)	6	1.2	2.6	1.6	3.7	3.7	8.2	5.2	11.6
902 (33cm)	9	1.6	3.7	2.3	5.2	5.2	11.6	7.4	16.4
902 (33cm)	12	2.3	5.2	3.3	7.3	7.3	16.4	10.4	23.2
1240 (23cm)	0	0.5	1.1	0.7	1.6	1.6	3.5	2.2	5.0
1240 (23cm)	3	0.7	1.6	1.0	2.2	2.2	5.0	3.1	7.0
1240 (23cm)	6	1.0	2.2	1.4	3.1	3.1	7.0	4.4	9.9
1240 (23cm)	9	1.4	3.1	2.0	4.4	4.4	9.9	6.3	14.0
1240 (23cm)	12	2.0	4.4	2.8	6.2	6.2	14.0	8.8	19.8

Note: Multiply above distances by 0.707 if duty cycle is 50% - such as during a typical back and forth communications exchange. To convert from meters to feet multiply meters by 3.28. Distance indicated is shortest line-of-sight distance to point where MPE limit for appropriate exposure tier is predicted to occur.

Table 4

Estimated distances from transmitting antennas necessary to meet FCC power-density limits for Maximum Permissible Exposure (MPE) for either occupational/controlled exposures ("Con") or general-population/uncontrolled exposures ("Unc"). The estimates are based on typical amateur antennas and assuming a 100% duty cycle and typical ground reflection. (The figures shown in the table generally represent worst-case values, primarily in the main beam of the antenna.) The compliance distances apply to average exposure and average power but can be used with PEP for a conservative estimate.

<i>Frequency (MHz)</i>	<i>Gain (dBi)</i>	<i>Distance from antenna (feet)</i>							
		<i>100 W</i>		<i>500 W</i>		<i>1000 W</i>		<i>1500 W</i>	
		<i>Con</i>	<i>Unc</i>	<i>Con</i>	<i>Unc</i>	<i>Con</i>	<i>Unc</i>	<i>Con</i>	<i>Unc</i>
2	0	0.5	0.7	1.0	1.6	1.5	2.2	1.8	2.7
	3	0.7	1.0	1.5	2.2	2.1	3.1	2.6	3.8
4	0	0.6	1.4	1.4	3.1	2.0	4.4	2.4	5.4
	3	0.9	2.0	2.0	4.4	2.8	6.2	3.4	7.6
7.3	0	1.1	2.5	2.5	5.7	3.6	8.1	4.4	9.9
	3	1.6	3.6	3.6	8.0	5.1	11.4	6.2	13.9
	6	2.3	5.1	5.1	11.4	7.2	16.1	8.8	19.7
10.15	0	1.6	3.5	3.5	7.9	5.0	11.2	6.1	13.7

		<i>50 W</i>		<i>100 W</i>		<i>500 W</i>		<i>1000 W</i>	
		<i>Con</i>	<i>Unc</i>	<i>Con</i>	<i>Unc</i>	<i>Con</i>	<i>Unc</i>	<i>Con</i>	<i>Unc</i>
50, 144, 222	0	3.3	7.4	4.7	10.5	10.5	23.4	14.8	33.1
	3	4.7	10.5	6.6	14.8	14.8	33.1	20.9	46.8
	6	6.6	14.8	9.3	20.9	20.9	46.7	29.5	66.1

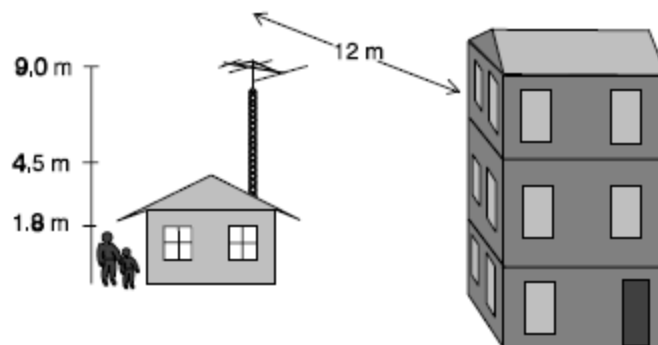
<http://www.arrl.org/files/file/Technology/tis/info/pdf/Table4567.pdf>

Vandamál

Ef vandamál koma upp skoða lausnir

Hugsanlegar lausnir

- Hækka loftnetið
- Færra loftnetið
- Ofi !



Forrit til útreikninga

- ▶ ITU K.70 forrit frá ITU
- ▶ Nýtt forrit IARU Svæðis 1 sem reiknar geislun frá loftnetum og öryggismörk.
 - [ICNIRPcalc](#)
 - Sjá <http://www.iaru-r1.org>
- ▶ Mælingar staðfesta

ITU.K70

EMF-estimator - D:\ITU_T_SG5\EMF_Estimator\EMF_estimator_v1_0\Examples\Figure_7_1\Figure_7_1_identification_v2.exp

Project Radiating source Print ICNIRP Reference Limits Cumulative exposure About

Radiation sources		Source - FM		Antenna orientation and calculations	
System name	robikem robikem	Type of service coefficient - nominal/mean transmitter power	FM	Electric field strength	1,67 [V/m]
TV_ch_31		Transmitter power	2000 [W]	Power density	7,356 [mW/m ²]
TV_ch_36		Feeder attenuation	0,481 [dB/100m]	Accompanied magnetic field strength (far-field region, plane wave)	4,417 [mA/m]
GSM900_source_1		Feeder length	35 [m]	Exposure limits	
GSM900_source_2		Additional attenuation	0,5 [dB]	Public	Occupational
		Total attenuation	0,67 [dB]	Electric field limit	28,00 [V/m] 61,00 [V/m]
		Gain referred to isotropic antenna	10,66 [dBi]	Power density limit	2,00 [W/m ²] 10,00 [W/m ²]
		Gain referred to $\lambda/2$ dipole	8,52 [dBd]	Compliance distance	24,08 [m] 12,75 [m]
		ERP	12195,4 [W]	Compliance distance(s) may be overestimated	
		HRP(ϕ)	-1,1188 [dB]	Simultaneous exposure to multiple sources	
		EIRP	20000,4 [W]	Mainly thermal effect: 100 kHz - 300 GHz	
		VRP(θ)	0,0722 [V/V]	Public Occupational	
		F(θ, ϕ)	0,063 [V/V]	This source	0,37 [%] 0,07 [%]
		EIRP (after type of service correction)	20000,4 [W]	All sources simultaneously	0,43 [%] 0,09 [%]
		Mechanical downtilt	0 [deg]	Mainly electrical stimulation effect: 1 Hz - 10 MHz	
		Transmitting antenna height	32,2 [m]	Public Occupational	
		Distance from the start to the observation point	10 [m]	This source	0 [%] 0 [%]
		Distance from the antenna to the observation point	29,64 [m]	All sources simultaneously	0,00 [%] 0,00 [%]
		Elevation angle from transmitting antenna to the observation point	160,3 [deg]	Field Regions :	
		Azimuth from the antenna to the observation point	-8,53 [deg]	from to	
		Frequency	98 [MHz]	Reactive near-field: (0, λ)	0 3,06 [m]
		Maximum size of the antenna	10,9 [m]	Radiating near-field: (λ ; $\max(3\lambda, 2D^2/\lambda)$)	3,06 77,68 [m]
				Far-field: ($\max(3\lambda, 2D^2/\lambda)$; ∞)	77,68 ∞ [m]
				EMF-estimator validity: ($0,62D^2/\lambda$; ∞)	24,08 ∞ [m]

Radiation sources

Source - GSM900_source_2

Antenna orientation and calculations

System name

FM

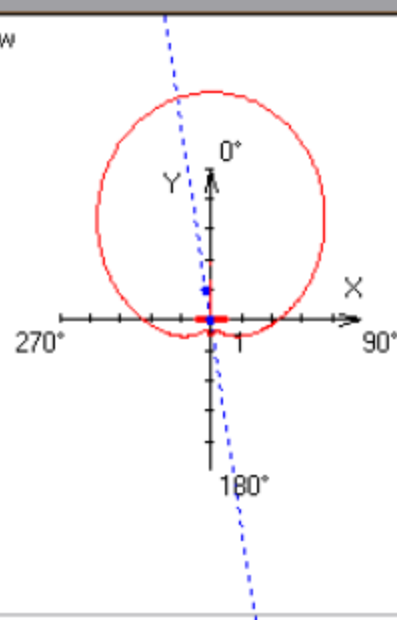
TV_ch_31

TV_ch_36

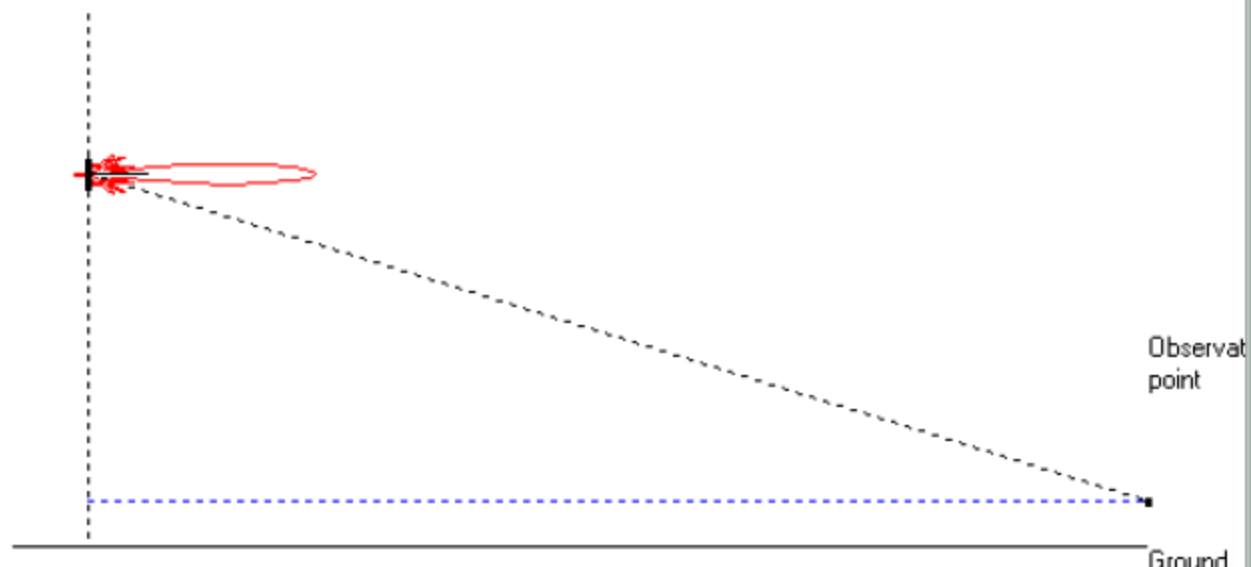
GSM900_source_1

GSM900_source_2

Top view



Side view



Orientation of the antenna [m]

Source point coordinates:

X

0

Y

0

Transmitting antenna height

35

Mechanical downtilt

0

Source azimuth [deg]

0

Observation point [m]

Distance from the start to the observation point

100

Distance from the antenna to the observation point

104,61

Observation point height

4,3

Elevation angle from transmitting antenna to observation point

107,1

Azimuth from the antenna to the observation point [deg]

-8,53

Calculation [m]

Coordinates of the calculation line:

Distance (horizontal) :

Start point : X

0

from

0

Y

0

to

200

Any next point : X

-0,15

step

0,25

Execute calculations

Observat point

Ground

EMF-estimator - D:\ITU_T_SG5\EMF_Estimator\!_EMF_estimator_v1_0\examples\Figure_7_1\Figure_7_1_identification_v2.exp

Project

Radiating source

Print

ICNIRP Reference Limits

Cumulative exposure

About

Radiation sources

System name

FM

TV_ch_31

TV_ch_36

GSM900_source_1

GSM900_source_2

Source - FM

Type of service coefficient - nominal/mean transmitter power

FM

Transmitter power

2000 [W]

Feeder attenuation

0,481 [dB/100m]

Feeder length

35 [m]

Additional attenuation

0,5 [dB]

Total attenuation

0,67 [dB]

Gain referred to isotropic antenna

10,66 [dBi]

Gain referred to $\lambda/2$ dipole

8,52 [dBd]

Antenna orientation and calculations

Electric field strength

1,67 [V/m]

Power density

7,356 [mW/m²]

Accompanied magnetic field strength (far-field region, plane wave)

4,417 [mA/m]

Exposure limits

Public

Occupational

Electric field limit

28,00 [V/m]

61,00 [V/m]

Power density limit

2,00 [W/m²]

10,00 [W/m²]

Compliance distance

24,08 [m]

12,75 [m]

Cumulative exposure - D:\ITU_T_SG5\EMF_Estimator\!_EMF_estimator_v1_0\examples\Figure_7_1\Figure_7_1_identification_v...

Simultaneous exposure - Public [%]

Hide sources

Copy

Distance [m]	FM [%]	TV_ch_31 [%]	TV_ch_36 [%]	GSM900_source_1 [%]	GSM900_source_2 [%]
0	0.70	0.00	0.00	0.70	0.00
20	0.35	0.15	0.40	0.95	0.00
35	1.30	0.35	0.25	1.85	0.00
40	1.00	0.45	0.10	1.60	0.00
60	0.30	0.15	0.05	0.60	0.00
100	0.10	0.05	0.02	0.20	0.00
150	0.50	0.20	0.05	0.80	0.00
200	0.70	0.20	0.15	1.10	0.00

ICNIRP CALC 1.1 DL9KCE

IconirpCalc v 1.1 ©2006-2011 Thilo Kootz DL9KCE

File Infos Language

Input

Ham-Band

Freq. [MHz]

Antenna

Power

Mode

Antenna Gain (dBi)

Cable Attenuation

Output

E-Field Limit [V/m]

Modulation Factor

Intermittend Factor

Ant. Input Power

EIRP

Saftey Distance

Distance [m]

Nearfield Conds [m]

Antenna | Mode | Cable Attenuation | Angle

Manufacturer	Name of Antenna	Data
		Freq. Gain # Ele.
Allgemein	Hexalbeam	28.00 5.770 2
Butternut		24.90 5.800 2
Comet		21.00 5.750 2
Create		18.10 5.810 2
Cubex		14.00 5.860 2
CueDee		10.10 5.790 2
CUEDEE		7.00 5.790 2
Cushcraft		
DF4SA		
DG3FEH		
DiaMond		
Dipol		
DJ2UT		
DJ9BV		
DK7ZB		
DL7IO		
Flexa		
Fritzel		
FTE		
GSRV		
GAP		
Grundmann		
HARC		
HyGain		
Jaybeam		

Chosen Antenna

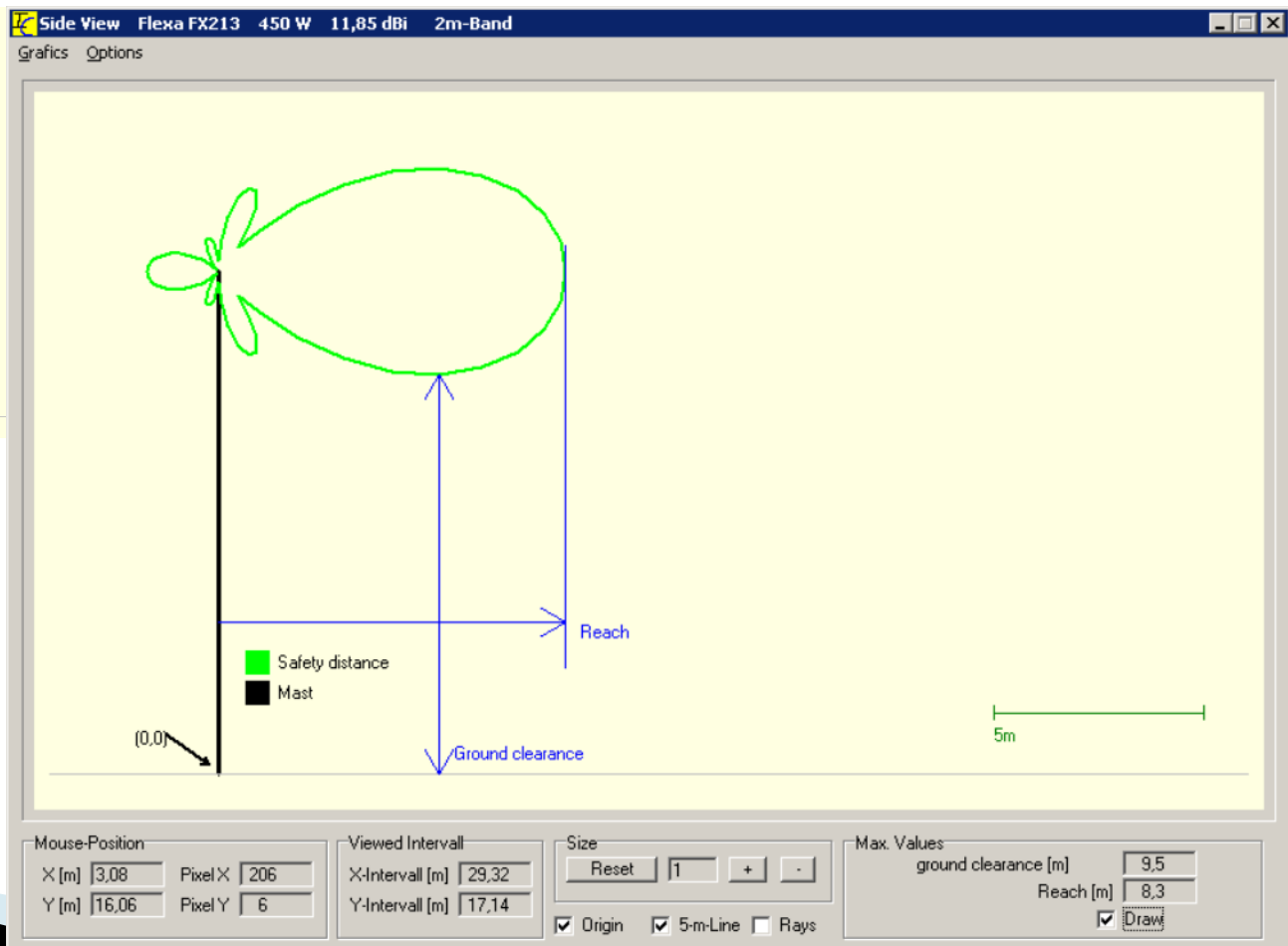
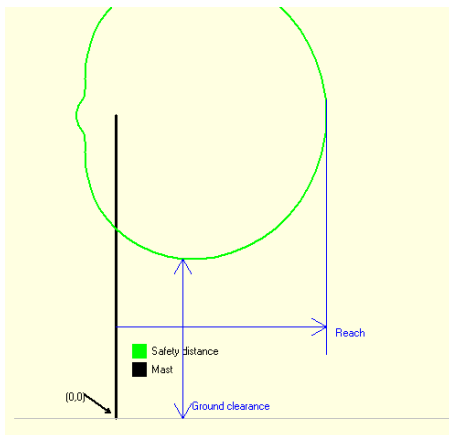
Name

Type

Gain

Angle Data Available

Take Antenna



File Infos Language

Input

Ham-Band 2m

Freq. [MHz] 144.00 - 146.00

Antenna

Power 500

Mode SSB

Antenna Gain [dBi] 0.00

Cable Attenuation 0.77

Output

E-Field Limit [V/m] 27.50

Modulation Factor 0.50

Intermittend Factor 0.50

Ant. Input Power 418.48

EIRP 418.48

Saftey Distance

Distance [m] 2.04

Nearfield Conds [m] 0.33

Antenna

Mode

Cable Attenuation

Angle

Mode

☐ CW ☐ FM ☐ DTX☒ SSB ☐ TV ☐ All☐ AM ☐ GSM

Factors

Modulation Factor 0.50

Intermittend Factor 0.50

Resulting Factor 0.25

Intermittend Operation

☐ TX6 RX0☐ TX4 RX2☐ TX2 RX4☐ TX5 RX1☒ TX3 RX3☐ TX1 RX5

When the safety distance is calculated used powered is averaged over period of 6 minutes. If only 3 minutes in a 6 minutes intervall is used for transmitting (TX3 RX3) mean power is decreased and safety distance as well. Since typical ham radio transmissions are simplex intermittend, declaring half the time as RX time is feasible.

Which Modulation Factors to use?

☒ FCC☐ Allways use 1☐ BNetzA (Germany)

FCC Value are in compliance with scientific literature

BNetzA Values are in compliance with German law

File Infos Language

Input

Ham-Band

Freq. [MHz]

Antenna

Power

Mode

Antenna Gain [dBi]

Cable Attenuation

Output

E-Field Limit [V/m]

Modulation Factor

Intermittend Factor

Ant. Input Power

EIRP

Safty Distance

Distance [m]

Nearfield Conds [m]

Antenna

Mode

Cable Attenuation

Angle

☐ Aircom plus

☐ Aircell 7

☐ H100

☐ H2000

☐ RG58

☐ RG174

☒ **RG213**

☐ RG220

☐ EcoFlex 10

☐ EcoFlex 15

Cable Length [m]

Attenuation [dB/100m]

Cable Length [m]

Cable Attenuation [dB]

Other Attenuations [dB]

Set All
Attenuations to
Zero

=

Combined Attenuation
between TX Output
and Antenna Input [dB]

0.77

IncirpCalc v 1.1 ©2006-2011 Thilo Kootz DL9KCE

File Infos Language

Input

Ham-Band 2m

Freq. [MHz] 144.00 - 146.00

Antenna X-5000

Power 500

Mode SSB

Antenna Gain [dBi] 4.50

Cable Attenuation 0.77

Output

E-Field Limit [V/m] 27.50

Modulation Factor 1.00

Intermittend Factor 0.50

Ant. Input Power 418.48

EIRP 1179.43

Safety Distance

Distance [m] 4.84

Nearfield Conds [m] 0.33

Antenna Mode Cable Attenuation Angle

DiaMond X-5000

Antenna polarisation
☒ Vertical ☐ Horizontal

Diagram

Antenna Height [m] 12

Antenna Side View

Angle	Attenuation	EIRP	Distance
0	1.20	894.69	4.21
10	2.60	648.15	3.59
20	4.50	418.48	2.88
30	6.70	252.16	2.24
40	9.00	148.48	1.72
50	12.00	74.42	1.21
60	15.00	37.30	0.86
70	18.00	18.69	0.61
80	21.00	9.37	0.43
90	23.00	5.91	0.34

Main Menu

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Ham-Band 2m

Freq. [MHz] 144.00 - 146.00

Antenna Dipol

Power 100

Mode SSB

Antenna Gain [dBi] 2.15

Cable Attenuation 0.77

Output

E-Field Limit [V/m] 27.50

Modulation Factor 0.50

Intermittend Factor 0.50

Ant. Input Power 83.76

EIRP 113.31

Manufacturer

Name of Antenna

Dipol

Dipol 1-4-1

Dipol 5-4-4

Dipol 15-24

Dipol 15-40

Dipol 45-100

Side View DiaMond X-5000 500 W 4.50 dBi HamB-Band

Graphics Options

(0,0)

Reach

Safety distance

Mast

Ground clearance

5m

Mouse-Position

X [m] -4.28 Pixel X 3

Y [m] 11.75 Pixel Y 125

Viewed Intervall

X-Intervall [m] 29.32

Y-Intervall [m] 17.14

Size

Reset 1 + -

☒ Origin ☒ 5-m-Line ☐ Rays

Max. Values

ground clearance [m] 10.9

Reach [m] 4.2

☒ Draw

Búið til loftnet

Construct your own Antenna

Name of Antenna

Type of Antenna (i.e. Yagi)

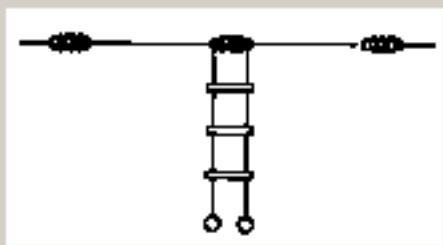
Category (i.e. Your Call)

Antenna Properties

Frequency [MHz]

Gain [dBi]

of Elements



Takk fyrir,

