最后报告

ITU-D
第2研究组

第7/2号课题
与人体电磁场暴露相关的战略和政策

第6研究期
2014-2017年

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第7/2号课题： 与人体电磁场暴露相关的战略和政策

最后报告

前言

国际电联电信发展部门（ITU-D）研究组提供一种文稿驱动工作的中立平台，政府、行业和学术界的专家在此聚集，制定实用的工具和导则并开发资源来解决发展问题。ITU-D成员通过ITU-D研究组的工作，研究和分析以任务为导向的具体电信/ICT课题，从而加快各国发展优先工作的进展。

研究组为所有ITU-D成员提供机会来交流经验、提出想法、交换意见，并就研究处理电信/ICT优先工作的适当战略达成共识。ITU-D研究组负责根据成员提交的输入意见或文稿来制定报告、导则和建议书。国际电联通过调查、文稿和案例研究收集的信息利用内容管理和网络发布工具公开提供，以方便成员的轻松访问。研究组的工作与ITU-D不同计划和举措相关联，以发挥协同作用，使成员在资源和专业知识上受益。与在相关议题领域开展工作的其他群体和组织进行协作至关重要。

ITU-D研究组的研究课题由四年一届的世界电信发展大会（WTDC）决定，每届WTDC为界定下一个四年的电信/ICT发展问题和优先工作制定工作计划和导则。

ITU-D第1研究组的工作范围是研究**“发展电信/ICT的有利环境”**，ITU-D第2研究组则是研究**“ICT应用、网络安全、应急通信和适应气候变化”**。

在2014-2017年研究期，由以下人员指导**ITU-D第2研究组**的工作：主席Ahmad Reza Sharafat（伊朗伊斯兰共和国）和代表六个区域的副主席：Aminata Kaba-Camara（几内亚共和国）、Christopher Kemei（肯尼亚共和国）、Celina Delgado（尼加拉瓜）、Nasser Al Marzouqi（阿拉伯联合酋长国）、Nadir Ahmed Gaylani（苏丹共和国）、王柯（中华人民共和国）、Ananda Raj Khanal（尼泊尔共和国）、Evgeny Bondarenko（俄罗斯联邦）、Henadz Asipovich（白俄罗斯共和国）和Petko Kantchev（保加利亚共和国）。

最后报告

针对**第7/2号课题：“与人体电磁场暴露相关的战略和政策”**的最后报告在报告人刘丹（中华人民共和国）的领导下制定，参与工作的有两位副报告人：Issoufi Kouma Maiga（马里）和Dirk Oliver Von Der Emden（瑞士）。ITU-D联系人和ITU-D研究组秘书处也协助他们开展工作。

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本报告由来自不同主管部门和组织的众多志愿人员编写。文中提到的具体公司或产品，并不意味着它们得到了国际电联的认可或推崇。

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内容提要

本报告收集并介绍有关人体暴露于电磁场（EMF）的信息，帮助各国主管部门，尤其是发展中国家的主管部门制定恰当的国家监管规定。本报告有助于各主管部门听取公众对辐射天线的担忧并对此做出反应。

EMF评定方法取决于站址和环境。计算适用于多种情况并具有显著优势（准确、快速且成本高效），而极为复杂的环境则需要测量。当电磁场辐射低且稳定时，现场调查会使公众放心，连续监测则具有有限的长远效益。许多国家都在运行测量调查和连续监测系统，调查和监测结果显示，移动通信系统对环境产生的平均射频一般低于0.1 μW/cm²。天线主瓣（主要是仰角）的方向是影响暴露程度的主要因素。

不同手机的最大特定吸收率（SAR）因技术和许多其他因素的不同而不同，例如，特定吸收率也受使用的天线及其在设备中放置的位置等技术参数的影响[1]。

通常，为限制人体和工人的电磁场暴露，包括欧洲国家在内的许多国家都以这样或那样的方式在立法中采用国际非电离辐射防护委员会（ICNIRP）1998年的国际暴露值。由于可知的科学不确定性，多国立法机构制定了防范措施，保护公众或一些弱势群体免予电磁场暴露。这些国家的规定一般建议采取防范措施将电磁场暴露度降低到ICNIRP 1998年参考水平以下。由于这些限制，为保持同等服务，天线数量有所增加。

在全国范围内遵守现行的ICNIRP 1998年基站和蜂窝手机限值。这些暴露限值是当前国际科学界协商一致的结果。人体对射频辐射的耐受力与地域范围或政治立场无关：不同国家设定不同的暴露值有据可依。蜂窝网络并非本地网络；一个国家的不同城市采用不同暴露值也没有工程技术依据；暴露值的定义应具有全国统一性，不受市或省委员会的管辖。全球标准有助于实现国际范围内的标准合规，加强利益攸关方之间的协作，保障透明度并加强与公民的沟通。

[1] 手机的SAR信息可查阅移动与无线论坛（Mobile & Wireless Forum）网站：http://www.sartick.com。

1 第1章 – 引言

1.1 背景

为满足城市和农村用户对电信和信息通信技术（ICT）的需求，不同来源的电磁场（EMF）部署迅猛增加。激烈竞争、话务量的持续增长、服务质量的要求、网络覆盖的扩大以及新技术的引进更是诱因。这使人们开始对长期暴露于辐射对人类健康可能产生的影响表示关切。[1]

对天线塔架电磁场暴露的日益担忧促使新的立法和/或规定的强行制定，以确保公众身体健康得到保护。持续电磁场辐射状态下对人类健康可能产生的危害已成为监管机构和服务提供商所面对的一个重要问题。

有关非电离辐射的规定包含暴露度标准和发射标准。暴露度标准是限制人体暴露于电磁场的规范，发射标准是限制设备电磁场发射的规范。

EMF评定方法取决于站址和环境。计算适用于多种情况并具有显著优势（准确、快速且成本高效），而通常只有极为复杂的环境才需要测量。现场监测对于保护在天线塔工作的工人的安全行之有效。而现场调查则使公众放心。当电磁场辐射低且稳定时，连续监测的长远效益无足轻重。

据国际电联[1]估计，约有70亿人（全球95%的人口）居住在移动蜂窝网络覆盖的地区。移动宽带网络（3G或更高级网络）覆盖了全球84%的人口，但却仅覆盖了农村67%的人口。对人们而言，电磁场既看不到也摸不着，加之缺乏了解和信息，可能会导致对电磁场缺乏信任，甚至可能转化为恐惧。

全球标准有助于实现国际范围内的合规性，加强利益攸关方之间的协作，确保透明度并促进与公民的沟通。

2009年，国际非电离辐射防护委员会（ICNIRP）[2]再次确认了其1998年有关“限制100KHz-300GHz范围内高射频场暴露的射频导则”。世界卫生组织（WHO）制定了有关无线电频率场的最新“环境健康标准（EHC）”专题论文。

超过一定的暴露电平门限后，人体或人体局部对射频（RF）EMF能量的吸收会导致人体体温升高。SAR限值的设定包含一定程度的安全余量，低于人体体温升高的门限电平。人体能够高效保温并在吸收任何来源的热量时以复杂的机制防止温度提升，这一点从我们具有在世界各地从冷到热各种不同气候条件下生存的能力上便可窥见一斑。

手机和其它无线系统的使用在全球迅速普及。一方面，这为人们加强公众和个人安全、改善教育、医疗和经济提供了机遇，另一方面亦为当地政府带来了新的责任和挑战。尤其值得一提的是，无线系统在造福人类的同时，亦给人们带来了健康风险忧患。

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1 国际电联，2016年ICT事实与数字（ICT Facts and Figures 2016）。

2 http://www.icnirp.org/cms/upload/publications/ICNIRPStatementEMF.pdf。

1.2 报告范围

本报告收集并介绍有关人体暴露于电磁场的信息，帮助各国主管部门，尤其是发展中国家的主管部门制定恰当的国家监管规定。本报告有助于各主管部门就公众对辐射天线的担忧（亦来自于超敏反应和电子恐惧症等毫无根据的论断）做出反应。

2 第2章 – 国际电联的决议

2.1 2014年全权代表大会（PP-14）的决议

2014年在大韩民国（报告其余部分称为“韩国”）釜山举办的全权代表大会（PP-14）批准并修改了有关“人体暴露于电磁场及其测量”的第176号决议。该决议：

责成三个局的主任“收集并分发有关人体暴露于EMF的信息，包括有关EMF测量方法的信息，从而帮助各国主管部门，尤其是发展中国家的主管部门制定适当的国家规则”；

请成员国“采取适当措施，确保国际电联及其它相关国际组织制定的人体暴露于EMF导则得到遵守”；

2.2 2014年世界电信发展大会（WTDC-14）的决议

在迪拜召开的2014年第六届世界电信发展大会（WTDC-14）批准了以下内容：

- “有关人体暴露于电磁场的测量问题”的第62号决议；
- 有关“与人体暴露于电磁场相关的战略和政策”的ITU-D第2研究组第7/2号课题；

研究的内容包括：

- “编纂并分析正在研究或执行中的、与人体暴露于电磁场有关的监管政策，这些政策涉及无线通信站址和电力线通信系统的安装授权。”
- “阐述相关战略或方法，提高大众在无线电通信系统所产生的电磁场效应方面的认识并增进他们对此问题的了解。”
- “就此问题拟议的指导原则和最佳做法。”
- 第62号决议中所含的“手持设备电磁场对人体影响”的新内容。

2.3 2016年世界电信标准化全会（WTSA-16）的决议

在哈马马特召开的2016年世界电信标准化全会（WTSA-16）就以下内容达成一致：

- 修订第72号决议 – “与人体暴露于电磁场相关的测量与评估关切”；
- ITU-T第5研究组第3/5号课题 – “人体暴露于信息通信技术产生的电磁场（EMF）”。

3 第3章 – 国际电联其他部门开展的工作

在整个研究期，本课题一直与国际电联其他部门和小组进行协调，包括：ITU-T第5研究组、ITU-R第1、5、6研究组及其相关工作组。

3.1 ITU-T研究组

3.1.1 第7/5号课题

第7/5号课题（修改为第3/5号课题）[3]。

新制定的建议书包括有关“为遵守无线电通信基站射频电磁场限值而进行环境管理的指南”的K.121（前身为K.env）建议书和有关“无线电通信天线周边暴露度”的K.122（前身为K.emf）建议书。有关“遵守人体暴露于电磁场限值的指南”的K.52建议书已进行了修订。

3.1.2 国际电联EMF导则

需要认识到，不同设计的移动电话基站在功率和特性上存在广泛差异，会影响到其将人体暴露在射频信号下的能力。研究表明，地面上，人体对基站无线电信号的暴露通常不到人体对移动电话暴露的千分之一。

移动电话基站功率根据移动电话呼叫数量、传播条件和承载的数据量的不同而不同。除数据和移动电话呼叫外，基站不停发射导频信号，使相关移动电话可以检测到该网络。

国际电联EMF导则（ITU EMF Guide，http://emfguide.itu.int）旨在回答公众常问的EMF问题，并消除相关忧虑。EMF导则提供知识和信息，传播适用于所有社群、利益攸关方和各国政府的信息。EMF导则中对WHO和其它利益攸关方旁征博引，并澄清了射频技术、基础设施实施、使用和EMF暴露后果等领域的一些科学不确定性。可在网站和应用商店中查阅。[4]

3.1.3 可持续智慧城市对EMF的考虑

为了提供覆盖和容量，基站需要靠近用户。基站和移动设备使用适配性功率控制，为保持连接质量，当连接条件良好时，它们将以最低的功率水平进行运作。

移动网络运营商正越来越多地采用多种基础设施模式。这主要出于商业和效率考虑而不是监管要求。基础设施共享可以是无源的，也可以是有源的：无源共享包括基站共享，即运营商使用相同的物理组件，但采用不同的基站塔、天线、机柜和回程。在有源

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[3] 第3/5号课题 – “人体暴露于信息通信技术（ICT）产生的电磁场”（Human exposure to electromagnetic fields (EMFs) from information and communication technologies (ICTs)）是第7/5号课题的延续。

[4] https:// play. google. com/ store/ apps/ details? id= intl. itu. ituemfguide& hl= en。苹果设备 – https:// itunes. apple. com/ au/ app/ itu- emf- guide/ id990872473? mt= 8。黑莓设备 – https://appworld.blackberry.com/webstore/content/59972970/?countrycode=AU&lang=en。

共享中，运营商可以共用无线接入网络（RAN）或核心网络；除天线、发射机和接收机外，运营商还可以共享频率。同样，运营商使用的技术平台之间可能存在兼容性问题。

附近的居民可能认为，周边地区天线数量增加会导致地面公众可及范围内人体暴露水平的上升。德国进行的测量表明，与天线的距离以及可见天线数量均不是射频暴露度的准确指数。相反，天线主瓣（主要是仰角）的方向才是影响暴露度的主要因素。

利用恰当障碍或标识限制接入具有显著作用。设备制造商应就合规区域的范围提供指南。在部署天线时，应进行安全距离评定以确定合规区域是否覆盖临近办公楼。这可能需要改变天线位置或降低发射机功率，从而确保符合EMF限值（ITU-T K.70建议书）。亦可参见**本报告第7章**中的示例。

3.1.4 ITU-T建议书

ITU-T K.52 – “有关符合人体暴露于电磁场（电信装置和手机）限值的指南”。该建议书通过提供EMF安全限值，帮助接近头部使用的电信装置和移动手机或其它辐射设备实现与标准的一致。电信装置的评估程序基于ICNIRP规定的安全限值，根据无障碍获取标准、天线特性和发射功率来帮助用户确定装置是否合规。

ITU-T K.61 – “有关为实现电信装置在人体暴露限值方面合规性而制定的电磁场测量和数值预测导则”。该建议书向电信运营商提供了符合当地和国家相关部门颁发的暴露标准的信息，同时还为实现合规评估提供了测量方法导则，亦提供了适用于各种情况下暴露度预测的所选数值方法导则。

ITU-T K.70 – “限制在无线电通信电台附近将人体暴露于电磁场（EMF）的缓解技术”。该建议书定义了电信运营商可用以评估发射天线附近累积（总）暴露比并确定主要辐射源的技术。还提供了缓解方法导则，而降低辐射水平。以便为遵守暴露限值针对辐射源可能同时来自多个频率、属于多家运营商且发射来自不同无线电通信业务（如蜂窝系统、集群系统、广播、无线电中继、无线接入等）的环境，该建议书还提供了有关必要程序的导则。

ITU-T K.83 – “电磁场场强监测”。该建议书针对如何在选定的公众关心区域进行长期电磁场场强（EMF）监测，以显示EMF在控制范围之内且在限值以下提供了指导。建议书的目的在于以连续测量结果的形式向公众提供清晰易得的有关电磁场场强的数据。

ITU-T K.90 – “关于网络运营商工作人员在工作频率电磁场遵守暴露限值的评估技术手段与工作程序”。该建议书提供了关于电信网络工作人员（如，在户外作业时）在功率频率（DC、50 Hz和60 Hz）情况下遵守人体暴露于电磁场（EMF）安全限值而采用的评估技术手段和指南，同时还提供了确定工作现场采取谨慎措施必要性的技术手段和程序。

ITU-T K.91 – “评定、评估和监测无线电频率电磁场对人体辐射的指导意见”。该建议书为如何在周围有无线电通信设施的区域，根据现行9 kHz至300 GHz频率范围内的人体电磁辐射及标准评定和监控人体暴露于电磁场（EMF）提供了指导意见。这包括评估暴露的程序以及如何表示暴露限值符合现行标准。建议书仔细研究了在真实环境中人们可以进入的、有各种不同射频电磁场源的业务在运行的地区的情况，并提及了与EMF合规产品相关的标准和建议书。

ITU-T K.100 –“通过测量射频电磁场判定一基站启动服务时是否符合人体暴露限值”。该建议书为评定当一新基站启用时是否符合公共电磁场（EMF）一般暴露限值提供了技术手段与程序，同时顾及其周边环境及存在的其它相关无线电频谱资源。

ITU-T K.113 –“射频电磁场电平图的生成”。建议书就如何制作电磁场地图提出指南，这些地图旨在帮助评定大片市区或土地的现有暴露程度，以及如何以简单易行的方式适当向公众披露结果。–“射频电磁场电平图的生成”。建议书就如何制作电磁场地图提出指南，这些地图旨在帮助评定大片市区或土地的现有暴露程度，以及如何以简单易行的方式适当向公众披露结果。

ITU-T K.121（前身为K.env）–“为符合无线电通信基站射频电磁场限值而进行环境管理的指导意见”。该建议书为在接近无线电通信设施的区域如何管理以遵守RF-EMF限值，以及如何制定流程以解决公众对RF-EMF的担忧提供了指导意见。

ITU-T K.122（前身为K.emf）–“无线电通信天线附近的暴露水平”。该建议书就广播和无线电通信天线附近的电场强度期望值提供了信息，以便与暴露限值进行对比。这不仅对维修人员很重要，在某些情况下对公众亦很重要。就工作人员而言，建议由专业人员对受影响操作人员进行培训，以便他们能够评判无线电通信天线附近区域的暴露水平。

3.2 ITU-R研究组

ITU-R 5A、5B、5C和5D工作组一致认为：“应在世界卫生组织（WHO）通过的科学依据基础上设定暴露限值。限制性限值的确定可能会影响无线网络的部署。”

5B工作组（包括全球海上遇险与安全系统（GMDSS）在内的海上移动服务、航空移动服务及无线电测定服务）在这一问题方面没有任何文档，并认为主管部门应各自出台对策解决人体暴露于非电离辐射环境中的问题。

ITU-R第5研究组5C工作组认为，固定点对点无线系统具有指向性，瞄准线上的链路不会对居住在天线附近的居民造成辐射，因为数据传输是以点对点的方式进行的。只有在天线旁瓣中，人体才会暴露在点对点链路中。

ITU-R第1研究组有关“频谱监测”的1C工作组认为，执行监测任务的主管部门或应更加重视自愿参测的个人手机和终端对蜂窝、广播和业余无线电台所产生影响的测量。1C工作组很乐于就此事宜继续与ITU-D和ITU-T协作。

有关“人体暴露于电磁场的测量”的第1/239号新课题研究：

a) 应采用哪些测量技术评估各类无线装置中的人体暴露情况？

b) 如何展示测量结果？

3.2.1 ITU-R建议书和手册

ITU-R BS.1698 – “估测由任何一频段内工作的地面广播发射系统产生的电磁场以评定在非电离辐射下暴露”。此建议书旨在推断并估测距发射机地点有一定距离的广播电台所产生的电磁辐射值。使用这类信息，负有责任的组织就能开发出可被用于保护人类免受不希望有的有害辐射的照射的合适标准。各主管部门的实际值取决于各国的暴露值。

ITU-R的频谱监测手册2011年修订版第5.6节详细阐述了有关“非电离”辐射的措施。

4 第4章 – 国际范围内有关EMF的活动和暴露限值

4.1 世界卫生组织（WHO）

Emilie van Deventer博士（世界卫生组织[5]公共卫生和环境司，瑞士日内瓦）在2016年4月22日世界卫生组织会议上介绍了“世界卫生组织：电磁射频场国家管理和监管方式”（WHO: Electromagnetic Radiofrequency Fields National Management and Regulatory Approaches）一文。她强调指出，评估无线技术长期影响的研究正在开展中。迄今为止，尚未确定射频场的环境暴露会对健康产生任何具体不良影响。她感谢国际电联三个部门帮助审议了世卫组织最近出版的“环境卫生标准（EHC）”专题论文、“基本安全原则和情况阐述”。世卫组织发布了EMF政策数据库[6]，她也指出了以下几点内容：各国政府面临的多项挑战，其中包括迅速发展的无线射频技术在投入市场前未经过任何健康评估以及世界各地的风险管理措施与监管之间的错位加深了民众担忧这一事实。各国政府或许希望明确在该问题上的职责职能，通过卫生标准并确保这些标准的执行。它们也可推动公共信息项目及与利益攸关方的对话并在可能的情况下进一步开展研究，减少科学不确定性。

4.2 ICNIRP 1998年导则 – 参考值

4.2.1 ICNIRP 1998年导则中适用于固定发射机的限值

援引ICNIRP“暴露指南”[7]（1998年，第495页）：“遵守参考值将确保遵守相关基本限制。如所测量或计算的值超过参考值，并非一定意味着，基本限值被超出。然而，当参考值超出时，有必要测试相关基础限制的合规性并确定是否有必要增加保护措施”。ICNIRP 1998年参考值得到多个国家的认可，各国的门限值均以这些参考值作为比照。ICNIRP 1998年（第511页表6和7）确定了暴露门限。以下各表和图具体说明了不同频率下的ICNIRP参考值。图中的暴露度值均为公众和职业暴露度值。低于10 MHz（波长30米），对人体的影响多数情况下取决于近场条件。参考值的提供主要针对电子场强(V/m) 。在10 MHz和300 GHz之间，该表亦在功率密度(W/m2)的基础上提供了基本限制，以防止在身体表面或接近身体表面的组织上产生过热情况。公众暴露的功率密度限值比职业暴露度限值低5倍。[8]

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5 http://www.who.int/peh-emf/en/。

6 http://www.who.int/gho/phe/emf/legislation/en/。

7 http://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf。

8 参见Haim Mazar所著《无线电频谱管理：政策、规则、标准和技术》（Radio Spectrum Management: Policies, Regulations, Standards and Techniques） – 书第9章，Wiley‘s出版公司。

表1：ICNIRP 1998年职业和公众暴露度参考值

频率范围	电子场强 (V/m)		等效平面波功率密度S_{eq}(W/m²)	
	公众	职业	公众	职业
1-25 Hz	10,000	20,000	功率密度限值不适用	
0.025- 0.82 kHz	250/f(kHz)	500/f(kHz)		
0.82 -3 kHz	250/f(kHz)	610		
3-1,000 kHz	87	610		
1-10 MHz	$87/f^{1/2}$ (MHz)	610/f (MHz)		
10-400 MHz	28	61	2	10
400-2,000 MHz	$1.375f^{1/2}$ (MHz)	$3f^{1/2}$ (MHz)	f/200	f/40
2-300 GHz	61	137	10	50

图1：ICNIRP 1998年职业和公众电子场强暴露

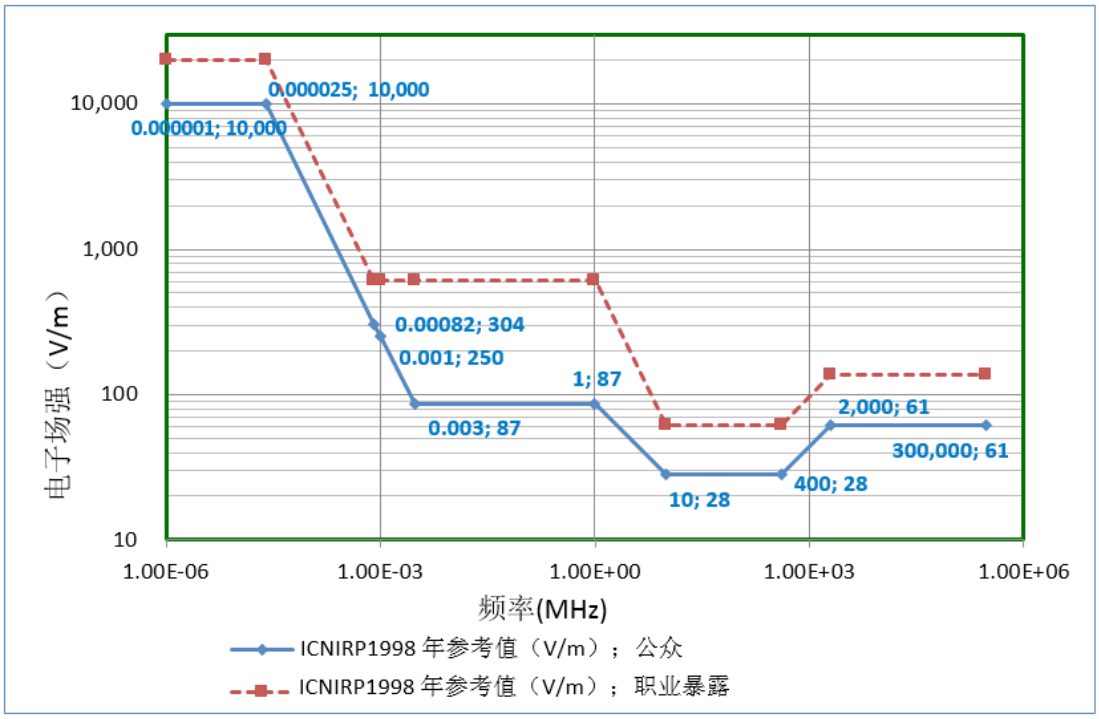
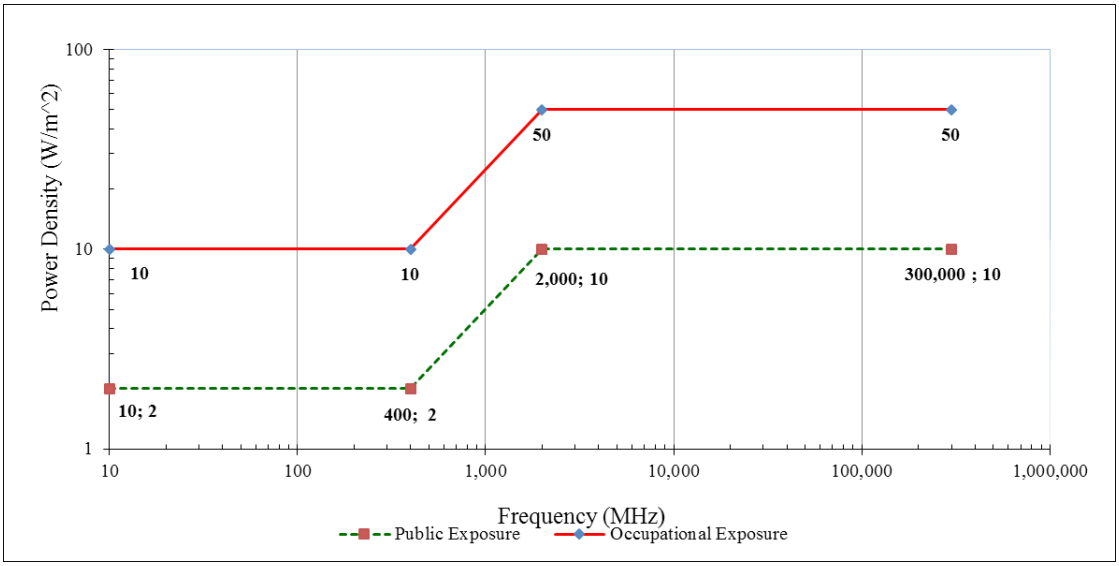


图2：ICNIRP 1998年功率密度参考值（仅用于10 MHz以上）



4.2.2 ICNIRP 1998年导则中适用于蜂窝手机的限值

公众面临的最多暴露来自于手机等手持设备。这些设备将多数射频能量置于大脑和周边组织。手机对大脑造成的典型暴露比房顶移动电话基站或地面电视广播电台多出若干数量级。就暴露水平而言，基站的固定辐射发射机和便携设备有所不同。固定发射机造成的暴露指所生成的场强和功率密度，而手机造成的暴露则主要根据10 MHz-10 GHz的特定吸收率（SAR）和10-300 GHz的功率密度[9]进行评判。产生两种不同方式的原因是，与功率密度限值相比，来自固定无线台站的远场[10]暴露方便进行分析（便于模拟和测量）。而在用户身体附近使用的手机，则意味着其设计与人体结合对近场[11]产生较大影响。与内部电场及因EMF造成的温度提升相关的SAR限定了手机等靠近身体使用的辐射源的门限值。就具体定义而言，SAR是“由递增物质吸收（散发）的递增功率推导出的时间，用W/kg表示。

表2比较了ICNIRP 1998、欧共体（EC）[12]、美利坚合众国、加拿大[13]和韩国在非受控环境下的SAR值并规定了人体局部的移动设备暴露限值。

[9] ICNIRP (1998)给出的这一频率范围的公众暴露限值为10 W/m²。

[10] ITU-T K.91建议书第7页和K.61建议书第2页将远场定义为：“视场分布与天线距离根本无关的天线场区。在远场区，场具有突出平面波特点，即电子场强和磁场强在垂直于传播方向的平面上局部统一分布”。

[11] ITU-T K.91建议书第8页将近场定位为“天线或其它辐射装置附近的近场区，在此，电子和电磁场没有突出的平面波特点，点与点差异巨大。”

[12] 参考资料ICNIRP 1998年第509页表4、1999年/519/EC附件3表1和IEC 62209-1、IEEE 1999年第29页。

[13] FCC 1997年OET公报第65第75条（FCC 2012 CFR 47 FCC § 2.1093）和1999年加拿大安全规则6. NOI FCC 13-39或R&O FCC 03-137 2013，保留SAR值不变。

表2：来自手机的最大功率：特定吸收率(SAR) (W/kg)

ICNIRP 1998	欧共体	加拿大、大韩民国和美利坚合众国
10 MHz至10 GHz； 本地SAR（头部和躯干）	10 MHz至10 GHz； 本地SAR（头部和躯干）	便携设备；普通大众/非受控
10 g组织以上平均2.0；（亦为IEEE C95.1-2005强度）	10 g组织以上平均2.0；（亦为IEEE C95.1-2005强度）	1g组织以上平均1.6

制造商遵守国际合规测试标准，确保在测试时，以最大功率运行的设备将符合相关的国际货国家限值。手机在最差连接条件（遇障碍或远离基站）下采用全输出功率工作，而在最佳连接条件下（视线以及接近基站）采用最小输出功率工作。

不同手机的最大SAR值根据技术和许多其他因素的不同而不同。例如，SAR还受所用天线及设备内天线位置等技术参数的影响。手机的SAR信息可查阅移动与无线论坛（Mobile & Wireless Forum）网站：http://www.sartick.com/。

4.3 区域、国家和比较暴露度限值

4.3.1 欧洲的EMF规则

欧洲第2013/35/EU号指令中规定了工作人员的暴露限值。欧洲各国在公众暴露限值上存在差异，因为欧盟委员会没有对基站设置公共暴露限值的法律根据。然而，欧盟委员会在理事会1999/519/EC建议书中推荐采用ICNIRP（1998）限值。一般来说，北欧比南欧更加严格地遵守1999/519/EC建议书。西欧和东欧国家没有明显差异（参见参考资料EMC-2016，EMF）。

在保护公众免受因发射机产生的EMF造成的暴露危害方面，欧洲各国在监管和具体落实措施上存在巨大差异。欧洲开展了大量监测活动，然而监测活动的范围和内容亦各不相同。

4.3.1.1 法律约束措施

多数欧洲国家遵从非强制性的欧盟理事会1999/519/EC建议 – “限制公众暴露于电磁场（0 Hz至300 GHz）”。该限值与ICNIRP 1998年人体暴露危害限值相同。一些欧洲国家采用更严格的参考值。欧盟委员会（EC）制定了“委员会有关落实理事会1999年7月12日建议的报告”，详细阐述了落实情况[14]。

4.3.1.2 暴露限值

通常，欧洲各国法律以某种方式采用ICNIRP 1998年的国际暴露限值，以便限制EMF的人体暴露。

[14] http://ec.europa.eu/health/ph_risk/documents/risk_rd03_en.pdf。

4.3.1.3 防范措施

由于现有不确定性，欧洲及其他国家的一些立法机构针对公众或可能的弱势群体颁布了防范EMF暴露的措施。通常，这些国家规定建议采用防范措施降低对EMF的暴露，将限值降低到ICNIRP1998年参考值以下。测量结果显示，公共区域的一般暴露值并没有因采用了更低的限值而降低[15,16]。欧盟委员会的一项调查[17]结果显示，限制性限值和其他防范措施会导致更严重的公众担忧。此外，为了维持同等质量的服务，限制性限值会导致天线数量的增加[18]。

4.3.1.4 合规认证

这项工作需要有权机构。本地规划局和城市议会通常负责这项工作（或是相同的负责指配频率、环境保护或卫生机构）。为表明合规，申请方应提供相关信息。通常管理机构采用预测模型计算发射机的暴露范围。

4.3.1.5 在发射机启用后执法

在某些情况下，根据管理机构的倡议，或公众因担忧提出请求后，进行定期和系统性（每年一次）测量（有时为常设射频辐射监测系统），监测发射机周围的安装情况，尤其是在敏感地区（学校、医院等）。

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15 “对移动通信无线电基站射频暴露调查进行的国际对比分析”（Comparative international analysis of radiofrequency exposure surveys of mobile communication radio base stations）。作者：Rowley等。摘自2012年5/6月《暴露科学与环境流行病学杂志》（Journal of Exposure Science and Environmental Epidemiology），22(3):304–315。

16 “欧洲不同城市户外环境中的射频电磁场（RF-EMF）暴露值与监管限值的比较”（Radio-frequency electromagnetic field (RF-EMF) exposure levels in different European outdoor urban environments in comparison with regulatory limits）。作者：Urbinello等。摘自2014年7月《国际环境》（Environment International），68(0):49-54。

17 TNS Opinion & Social应健康与消费者保护总司开展的“第347号欧洲晴雨表专题：电磁场”调查（Special Eurobarometer 347: Electromagnetic Fields, Conducted by TNS Opinion & Social at the request of the Directorate General for Health and Consumer Affairs），并与通信总司进行了协调。2010年6月。

18 “降低电磁场暴露限值对当前UMTS网络的影响”（The impact of EMF exposure limits reduction on an existing UMTS network）。作者：Ni u，摘自2015年《布加勒斯特政治大学科学公报》（University Politehnica of Bucharest Scientific Bulletin），C系列，77(3)：123-134。

5 第5章 – 根据调查回复开展的案例研究

ITU-D第2研究组及其1/2工作组2015年9月会议同意发布一项联合调查问卷以收集有关与人体暴露于电磁场相关的战略和政策（第7/2号课题）和其他研究课题的最新情况并要求成员就这些问题提交输入文件。截止日期前，第7/2号课题收到了24个国际电联成员国和ITU-D部门成员的回复。对这些输入文件进行的分析有助于各国开展并加强人体暴露于电磁场的能力建设。详情见本报告**附件1**。

表3：调查回复摘要

问题	回复
1. 贵国是否有规定暴露限值的标准或规范？	81%的国家采用非电离辐射保护国际委员会（ICNIRP）导则；13%的国家制定了不同于ICNIRP导则的本国标准或规范；1%的国家正在制定国家标准或规范；5%的国家没有规定暴露限值的标准或规范。（23个回复）
2. 贵国现有哪种形式的立法和/或监管措施？	17个国家制定了法律，9个国家拥有法令，9个国家制定了规范，4个国家拥有其它法律和/或规则。（23个回复，答案不止一个）
3. 贵国存在何种政府组织机构为此负责？	17个国家具有负责制定标准/规范的机构/部门；17个国家具有负责监测的机构/部门；9个国家具有与评定健康影响的机构/部门；18个国家具有负责执行的机构/部门；8个国家具有负责测试和批准基础设施建设的机构/部门；5个国家具有其它机构。（24个回复，答案不止一个）
4. 对可能的敏感区域（学校、医院等）和脆弱人群（孕妇、儿童等）采取了何种措施？	12个国家具有在敏感地区树立天线塔的限制；9个国家一直采取积极有效的措施；13个国家针对需求采取措施（等）；10个国家通过网站或其它媒体分享信息；7个国家采取了其它措施。（21个回复，答案不止一个）
5. 评估一个无线电通信站点大约需要多长时间？	59%的国家需要不到30天；25%的国家需要30-60天；15%的国家需要60-80天；1%的国家需要180天以上。94%的国家将时限规定在法律/法令/规范/导则中。（21个回复）
6. 评估一个常规状况下（用于人口聚集区)使用的无线电通信站点大约需要多少费用？	79%的国家收费低于5000美元；16%的国家收费在10,000-15,000美元之间；5%的国家收费超过15,000美元，没有收费在5,000至10,000美元的国家。11%的国家将收费规定在法律/法令/规范/导则中。（19个回复）
7. 评估无线电通信站点的费用由谁来支付？	12个国家的监测机构开展测量，由无线电通信站点所有者付费的有13个国家；由申请允许在私人地产内建立基站的个人或机构付费的有8个国家；由他人付费的有3个国家。（28个回复，答案不止一个）
8. 贵国对移动通信终端设定具体吸收率（SAR）值是多少？	90%的国家采用ICNIRP导则；10%的国家具有本国的SAR限值。（21个回复）
9. 贵国在部署无线电基础设施时有无特殊的立法和/或监管措施？	83%的国家具有部署无线电通信基础设施的特别法律和/或规则。（23个回复）)
10. 在如何提高公众对于人体暴露于电磁场方面的认知方面有哪些好的做法？	20个国家通过网站或其它媒体介绍专业领域知识；11个国家定期或不定期举办研讨会；5个国家通过移动运营商使用批量SMS；10个国家创建专门网站并通过社交媒体交流信息；6个国家通过移动应用提供信息；3个国家采用其他方式。（22个回复，答案不止一个）

问题	回复
11.在如何将暴露信息提供给公众方面有哪些好的做法？	17个国家通过网站或其它媒体（包括广播）介绍了专业领域的相关测量结果；14个国家介绍了相关机构在专业领域内的相关测量结果；6个国家通过网站介绍了规则的变化；7个国家通过移动运营商使用批量SMS；8个国家创建了专门网站并通过社交媒体交流信息；10个国家通过移动应用提供信息；3个国家采用其它方式。（25个回复，答案不止一个）
12.贵国是否强制无线通信站点拥有者执行义务？	17%的国家定期测量并分发信息；11%的国家定期分发提高认识资料；71%采用其它方式；1%国家未执法。（23个回复）

6 第6章 – 暴露度限值的比较

欧洲各国、日本和中华人民共和国（本报告其余部分简称为“中国”）在移动设备人体局部暴露上均使用每10g SAR 2 W/kg的限值，然而，在韩国、美国和加拿大，限值为每1g 1.6 W/kg。在，400-1500MHz（包括蜂窝传输和UHF电视频段），ICNIRP、欧洲和韩国针对公众暴露的最大允许功率密度值（PD）值为f (MHz)/200 W/m2。在300-1500MHz范围内，美国和日本的门限值为f (MHz)/150 W/m2，比ICNIRP 1998年门限值高出4/3（200/150）。像日本一样，美国也允许基站射频暴露具有更高的门限值。[19]

必须强调的是，美国、加拿大和韩国有关蜂窝终端可允许的SAR规定比1999/519/EC和IEEE C95.1-2005更加严格。需要注意的是，FCC的限值以旧版IEEE标准（C95.1-1991）为基础（该标准现已更新[20]以便于ICNIRP保持一致）。欧共体和IEEE采用的ICNIRP 1998门限为**2.0** W/kg，而韩国的FCC § 2.1093和加拿大有关人体局部的安全标准SC6为**1.6** W/kg。这种情况似乎合乎情理（至少与各国相比，将ICNIRP 1998功率单位提升至100），因为手机和笔记本电脑与从基站接收的信号相比对射频能量的接收更强且更靠近用户的躯体。美国和日本对有关固定发射机的不确定性风险的监管最宽松。

表4提供了全面的比较情况：法国、英国、美国、中华人民共和国、日本和韩国相对于ICNIRP 1998公众参考值（欧共体和IEEE采用的）的限值：1 000MHz PD 5 W/m2，SAR 2 W/kg。参考值是以1000MHz频率为基础计算的并显示出移动设备人体局部暴露限值的平均SAR。**表4**每行按PD分类，ICNIRP值百分比从大到小排列，由此看出，中华人民共和国的规定（0.08 ICNIRP值）最严格。

[19] 见Mazar：人体暴露与射频限值：欧洲、美国、加拿大、中华人民共和国、日本和韩国参考值更新：《EMC欧洲Wroclaw》，2016年。

[20] 维护C95系列标准的国际电磁安全委员会（ICES）解释，1991年的SAR限值仅以早期剂量测定考虑为基础，而2005年限值的设定基础则是对射频和热剂量学以及生物/健康作用有了更好的理解。（参见C95.1-2206中的C.2.2.2.1.1）。

表4：功率密度和SAR的全面比较

国家	PD 1,000 MHz (W/m²)	SAR (W/kg)
美国	f/150 =6.67; 133/%	1 g以上组织平均1.6
日本		10 g以上2.0
法国和 英国	f/200 =5; 100%	
韩国		1g以上组织平均1.6
加拿大	0.02619f 0.6834 =2.94; 59%	
中华人民共和国	0.4; 8%	10 g以上2.0 W/kg

注：[a] 这也是ICNIRP和IEEE 2006年参考值。

以下数字描述了围绕地面发射机的暴露范围。[21] 对于透明度，描述场强或相对于国家参考值的功率密度的基站数字已公布给生活在地面电台周边的公众。以下计算考虑到地形图和建筑物并采用了ITU-R P.526-13建议书（衍射传播，1994年，Deygout）。计算得出的距离短于自由空间模型。假设自由空间传播损耗，地面电台周边的场强e为 $e = \frac{\sqrt{30 \times eirp}}{d}$，即在不考虑建筑物和障碍的情况下，通过插入场强参考值便可轻而易举地得出暴露距离。ICNIRP 1998年规定的公众限值为e，电台周边的安全距离为 $d = \frac{\sqrt{30 \times eirp}}{e}$。

[21] 这些数字由Eng. Hervé Napoletano工程师拟定。

7 第7章 – 发射机周边的场强

7.1 调频（FM）发射机周边的场强

以下分析针对eirp 60 000瓦、地面高度60米的FM 100MHz发射机全向天线。[22]传播模型考虑到建筑物衰减。尽管难以忽视，但为简化，计算中未考虑天线的**仰角辐射**以及**近场作用**。

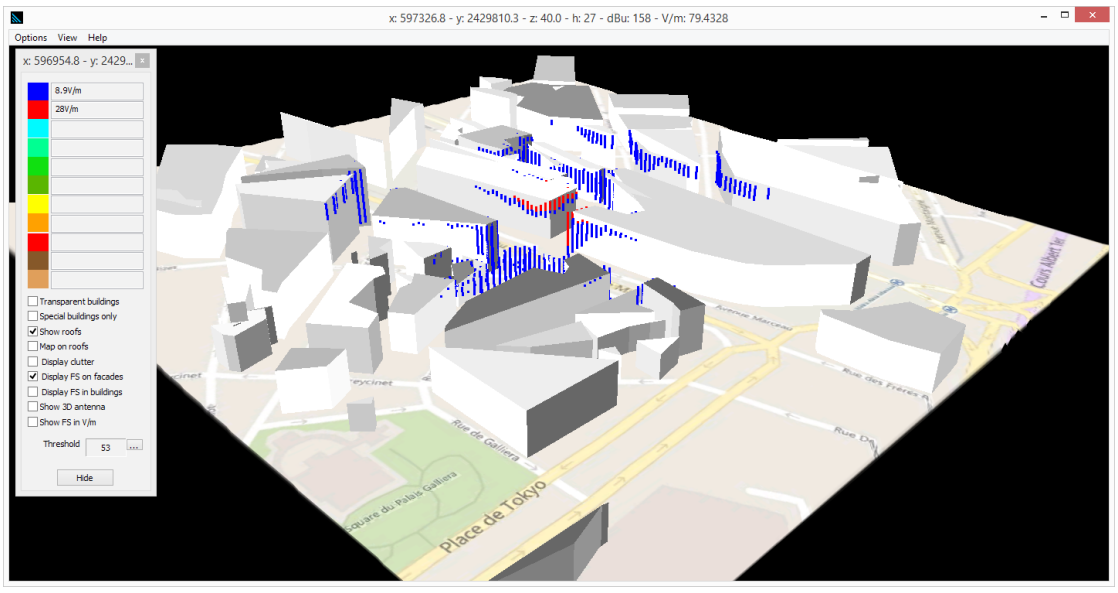
在100 MHz情况下，ICNIRP电子场强（V/m）公众参考值为28 V/m。由于一些国家将ICNIRP功率密度除以10，以下数字亦基于8.9 V/m（28除以$\sqrt{10}$）。

假设自由空间传播损耗，$e = \frac{\sqrt{30 \times eirp}}{d}$，在不考虑任何建筑物和其它障碍的情况下，用$d = \frac{\sqrt{30 \times eirp}}{e}$轻而易举地计算出安全距离。

对于60 kW 的eirp，自由空间传播损耗安全等值线在28V/m的条件下为48m、8.9V/m为151m。

考虑到地形图和建筑物、非自由空间传播损耗、计算得出的距离更短（参见**图3和图4**）。

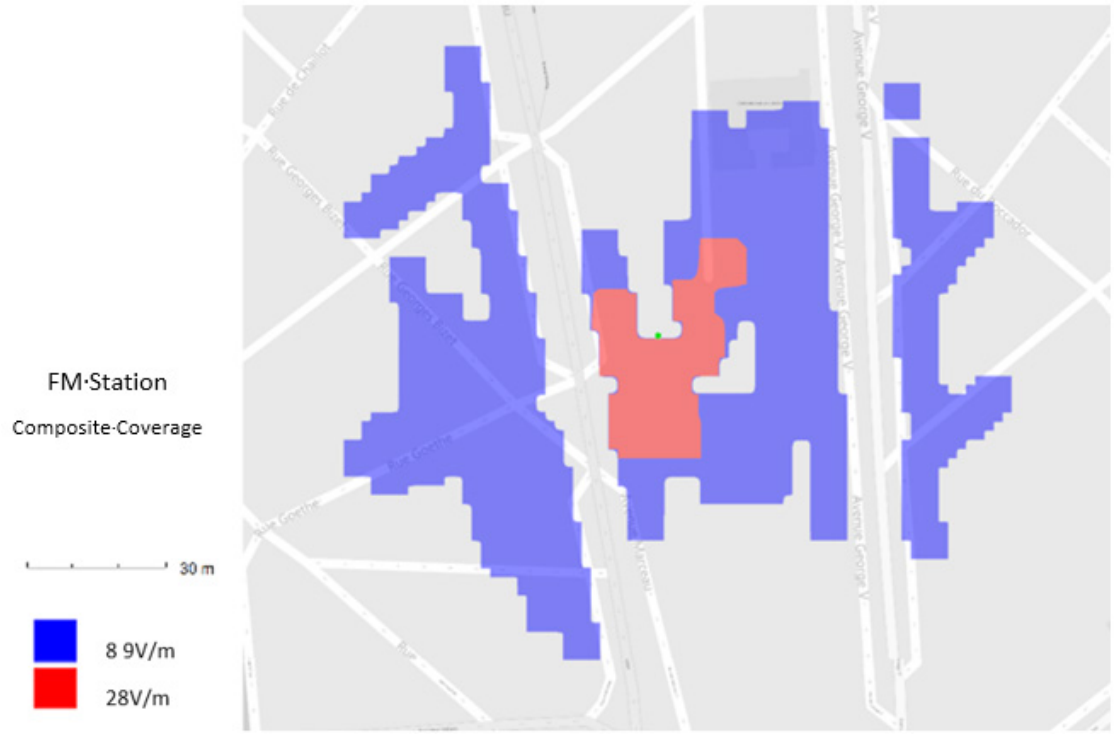
图3：三维FM暴露等值线



来源：法国ATDI

[22] 参见2015年7月6日ATDI提交的ITU-R第6/395号文件。

图4： 二维FM暴露等值线



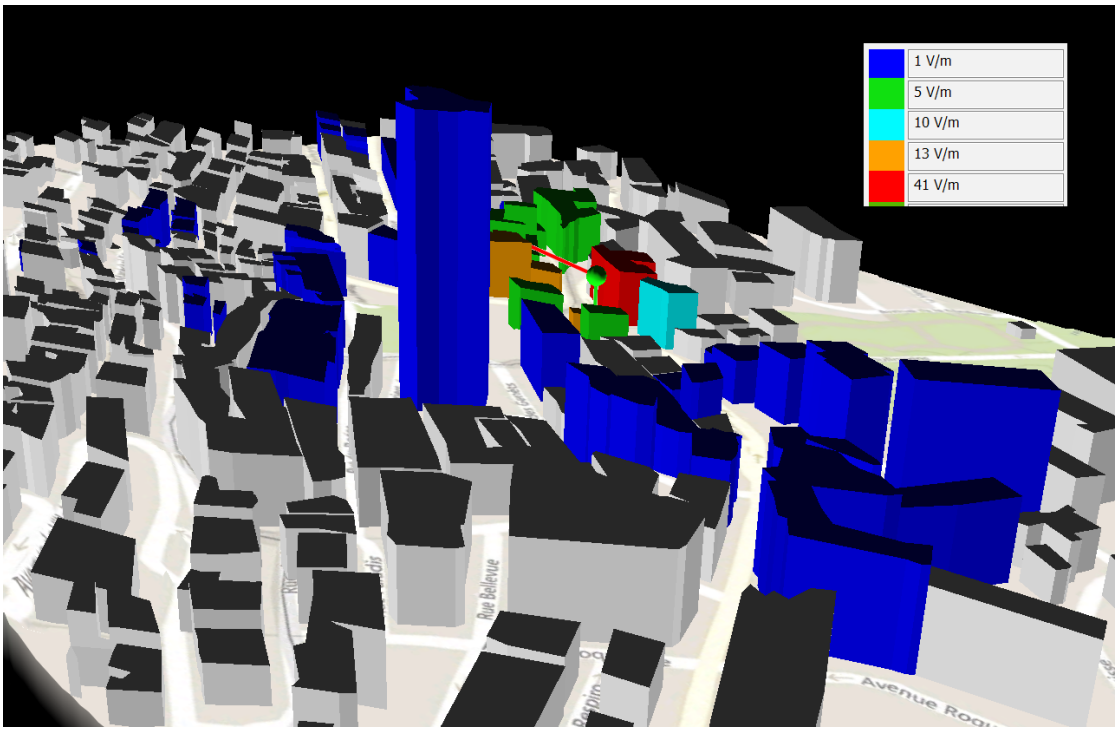
来源：法国ATDI

7.2 蜂窝发射机周围的场强

尽管不可忽视，但为简化，计算中未考虑天线的仰角辐射和近场的增益削减效应。[23] 实际上，对于蜂窝基站，发射机下的天线增益很低。考虑到仰角辐射的二维图将混淆视听。在900MHz情况下ICNIRP电子场强（V/m）公众参考值为41 (1.375f $^{1/2}$ = 1.375 × 30) V/m。一些国家用10除以ICNIRP功率密度。**图5**的三维图亦基于13 V/M（用 除以41，因为场强与功率的平方根有关）。对于100 W的最大下行链路功率和17 dBi的天线增益（包括损耗），eirp为5 kW，自由空间户外传播损耗安全等值线在41 V/m的条件下为9.5m，13V/m为30 m。

[23] 参见2016年1月25日ATDI提交的ITU-R第5A/8号文件。

图5：三维蜂窝暴露等值线，显示受到影响的建筑物



来源：法国ATDI

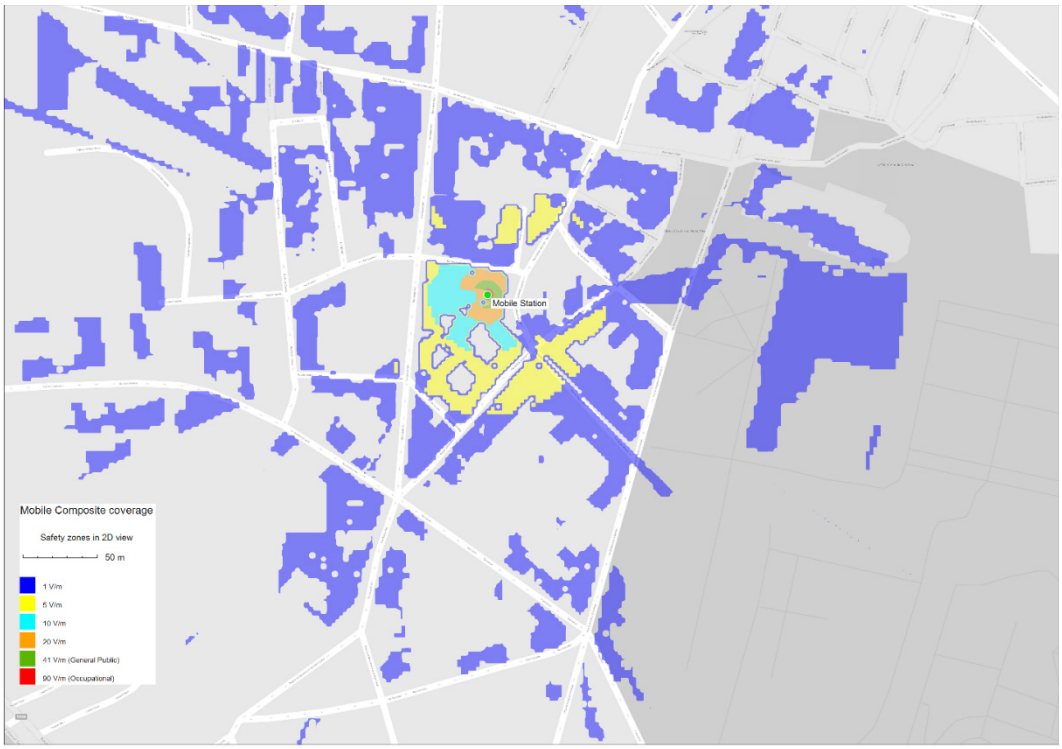
对于同一台蜂窝发射机，下文中的二维图描绘了高于地面或屋顶1.5米的接收天线的下行链路安全区域。考虑到墙壁的弱化作用，1.5米的AGL移动接收机的室内覆盖效果非常弱。法国权威机构的建模显示，限制性限值会导致室内覆盖质量的降低。[24] **图6**也描绘了职业暴露的安全距离。ICNIRP（参见表1）的公众参考值是41 (1.375f 1/2 = 1.375 × 30) V/m，职业参考值是90 V/M: 3f 1/2 (MHz)；场强值（field-strength scales）为1、5、10 、20 、41（公众）和90（职业）V/M。下图描绘了3D视图下受影响的建筑。

许多国家都在开展测量调查和运作持续的监控系统，这些调查和监控结果显示[25]移动通信系统的平均环境射频水平一般不到0.1 μW/cm²。

[24] Concertation et information locales dans le cadre de l'implantation d'antennes relais. Diminution de l'exposition aux ondes électromagnétiques émises par les antennes relais de téléphonie mobile。FRANÇOIS BROTTES的第一阶段报告，2011年8月30日。

[25] “意大利国家固定射频监测网络观察报告”（Observations from national Italian fixed radiofrequency monitoring network）。作者：Rowley等，摘自2016年2月《生物电磁学》（Bioelectromagnetics），37(2):136–139。

图6：二维蜂窝暴露距离



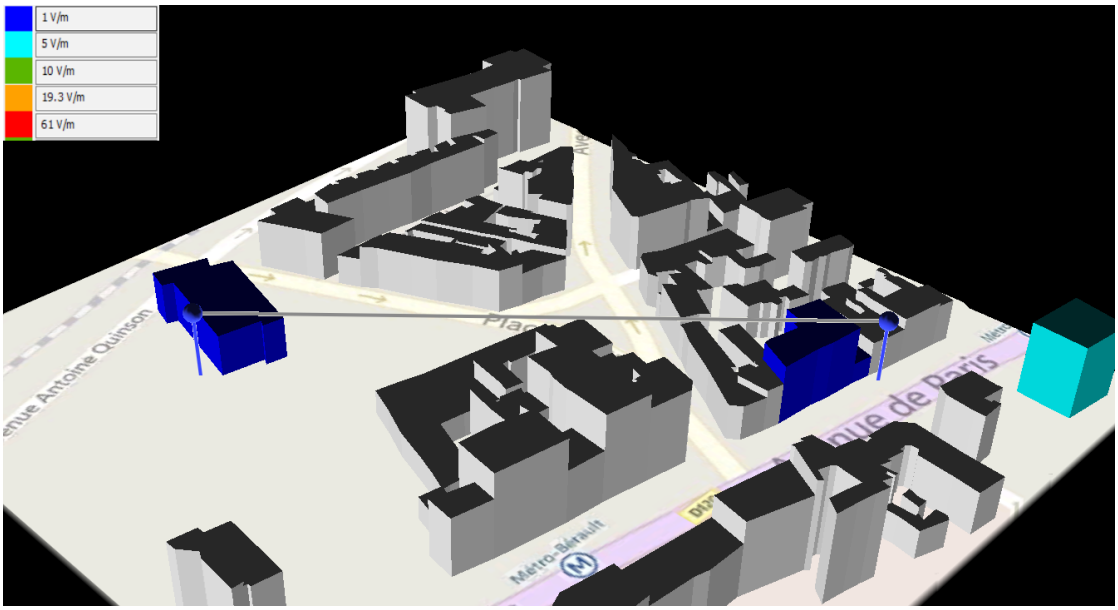
来源：法国ATDI

7.3 点对点发射机周围的场强

ITU-R F.699-7建议书中可查阅到天线仰角和方位角的辐射图（与圆形天线辐射图类似）。在10 GHz情况下，ICNIRP 1998年电子场强（V/m）公众参考值为61 V/m。一些国家用10甚至更大数字除以ICNIRP功率密度。以下3D图亦基于19.3V/m（$\sqrt{10}$ 除以61）和更低场强值。[26] 对于2 W的最大功率和43 dBi的天线增益（包括损耗），eirp等于40kW。自由空间损耗暴露等值线在61 V/m的情况下为18 m、19.3 V/M为57 m。下图描述了eirp为40kW的两个点对点发射机场强，使用各项同性天线（指向天线偶尔会出现修改方位角或仰角的情况）或定向天线。

[26] 参见2016年3月29日ATDI提交的ITU-R第5C/17号文件。

图7：采用ITU-R F.699天线辐射图得出的三维暴露（ eirp为40 kW ）



来源：法国ATDI

图8：采用ITU-R F.699天线辐射图得出的二维暴露距离

来源：法国ATDI

8 第8章 – 利益攸关方的职责和国家做法

8.1 国家管理机构的作用

由于立法框架不同，各国管理机构的作用和职责或许迥然相异。

规划机构和监管机构可能肩负的责任：

- 保护公众健康；
- 授权发射机选址；
- 为发射机制定规划规则；
- 批准发射机周边的土地使用；
- 与其它利益攸关方协调。

发射机所在站点或网络运营商希望发射机使用的站点土地所有者可能承担的责任：

- 决定是否租用站点；
- 发挥友善邻里作用；
- 利用土地所有者的地位促进当地重点事业的发展。

网络运营商可能承担的责任：

- 运行无线电遥测网络以监测本地基础设施状况；
- 运行专用移动无线电网络以便于员工通信；
- 运行WiFi网络以满足公众使用；
- 遵守规则要求。

雇主可能承担的责任

- 为工作在无线网络发射机周边的员工履行职业健康和安全责任。

可能承担的信息来源责任：

- 引导有关卫生问题的公众宣传；
- 回答本地居民、当选代表提出的有关无线网络的问题；
- 传达国家卫生机构的意见。

8.2 一些国家的做法

表5：国家做法

政策类别	实施规划	国家
人体暴露于电磁场的安全限值	总体遵循ICNIRP导则	巴西、韩国、以色列、贝宁、中国
	确定本国标准	科特迪瓦、乌兹别克斯坦
立法和监管模式	公布法律以监督基站对人体健康和周边环境的影响	乌兹别克斯坦、贝宁、中国
	设立评定和批准基站安装或重新安置的专门机构	科特迪瓦、匈牙利、中国、巴西、韩国
	对敏感地区和薄弱群体采取保护措施	科特迪瓦、贝宁
	根据相关法律、规则和社会要求，定期在全国范围内测量电台	科特迪瓦、巴西、以色列、匈牙利、贝宁
	确定基站所有者的义务	科特迪瓦
信息披露	在监管机构网站上介绍相关知识和测量结果	科特迪瓦、巴西、韩国、以色列、匈牙利、中国
	在监管机构网站上显示EMF限值的监测软件和违规情况	以色列

8.3 限制人体射频场暴露的政策

世界各地蜂窝基站场强、人体暴露监测和理论评估表明[27]，暴露水平大大低于ICNIRP 1998年参考值，因此，人们可能提出这些问题：

- 如每千用户一个基站，基站数以千万，在此情况下，我们是否有必要为合规而对每个基站从零开始执行安装后措施？
- 如能在公民因忧虑提出具体要求后才进行后续测量，为何要在全国范围内进行事先监测？

既然地面公共区域的测量结果总体显示出非常低的暴露水平，一些主管部门考虑是否ICNIRP1998年参考值设定得过高，甚至考虑过降低标准。ICNIRP参考值是根据已制定的健康危害标准设定的，并持续接受审议，并非以技术作为设定基础。此外，这种说法忽略了暴露限值的降低意味着必须要管理更大范围的天线合规区域这个事实。

就在本报告撰写之时，ICNIRP正在准备对1998年的100KHz至300GHz频率导则进行更新，预计2017年底将完成草案。

[27] 参见Mazar的著作《无线电频谱管理：政策、规则、标准和技术》（Radio Spectrum Management: Policies, Regulations, Standards and Techniques）第9章，Wiley's出版公司。

8.3.1 减少人体暴露的政策

基于防范原则，可采用以下政策降低人体的暴露程度：

- 在全国范围内遵守ICNIRP 1998年有关台站和蜂窝手机的限值。这些暴露限值是当前全球科学界协商一致的结果。人体对射频辐射的容忍与地域或政治立场无关：各国采用不同暴露值在技术上是站不住脚的。蜂窝网络并非本地网络，一个国家不同城市采用不同暴露值没有工程技术依据。暴露值的定义必须具有全国统一性，不受城市或省委员会的管辖。
- 使用一目了然的标签，显示超出限定值的微波或电磁场的存在、发射功率或设备SAR以及任何使用造成的已知健康风险；
- 若从竞争、成本、容量及覆盖范围的角度具有可行性，考虑使用其他暴露水平可能更低的媒介；
- 促进运营商之间蜂窝基站的无源并置（采用共同的站点、线杆和天线）甚至有源共用（相同的收发信机和频率），以便减少蜂窝基站的数量；
- 不限制敏感地区的天线塔建设，因为基站天线数量的减少将加大手机功率，使个人手机暴露度提升[ITU-T K.91 2012]；
- 通过仿真明确告知公众现有和未来暴露值。对于手机，提供唾手可得的SAR值出版物；
- 从理论上分析每个基站以确保公众暴露低于ICNIRP1998年参考值；根据需求进行测量；使用软件监测暴露情况和全年365天每天24小时发射的功率。

8.3.2 降低射频暴露水平的缓解技术

可采用下列方式降低人体暴露程度：

- 限制进入暴露值超标地区、实施物理障碍和封锁程序且全面标注均必不可少。工人可穿戴保护服装（ITU-T K.52建议书）；
- 增加天线高度。加大到所有调查点的距离并降低辐射水平。此外，加大偏离仰角并缩小发射天线旁瓣以进一步减少辐射（ITU-T K.70）；
- 提高天线增益（主要通过较低仰角宽度）并减少人们面对的辐射。纵向波束宽度可用来降低天线周边的辐射。此外，低功率发射机馈入高增益天线或高功率发射机馈入低增益天线均可实现相同的eirp值。从防止辐射角度而言，更佳选择是使用低功率发射机馈入高增益天线（ITU-T K.70）；
- 为保持质量标准，将基站发射降低到满足服务质量必不可少的最低水平。降低发射功率并由此线性降低所有观测点的功率密度。由于这种缓解技术缩小覆盖范围，因此仅在其它方法不可用时才使用这种方法（ITU-T K.70）。

Abbreviations and acronyms

Various abbreviations and acronyms are used through the document, they are provided here.

Abbreviation/acronym	Description
3G	Third Generation
ANSI	American National Standards Institute (United States of America)
BBC	British Broadcasting Corporation
BDT	Telecommunications Development Bureau
EC	European Commission (executive body of the European Union)
EHC	WHO Environment Health Criteria
ELF	Extremely Low Frequency
EMF	Electromagnetic Fields
ETRI	Electronics and Telecommunications Research Institute (Republic of Korea)
EU	European Union and European Commission
FCC	Federal Communications Commission (United States of America)
FG	Focus Group
GHz	Gigahertz
GMDSS	Global Maritime Distress and Safety System
HF	High Frequency (3-30 MHz)
Hz	Hertz (the base unit of frequency)
IARC	International Agency for Research on Cancer
ICES	International Committee on Electromagnetic Safety
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICT	Information and Communication Technologies
IEC	International Electrotechnical Commission
IEEE – SA	Institute of Electrical and Electronics Engineer – Standards Association
ITU	International Telecommunication Union
ITU-D	ITU Telecommunication Development Sector
ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Telecommunication Standardization Sector
KEPCO	Korea Electric Power Corporation (Republic of Korea)
kHz	Kilohertz
MF	Medium Frequency
MFN	Multi Frequency Network
MOTIE	Ministry of Trade, Industry and Energy (Republic of Korea)

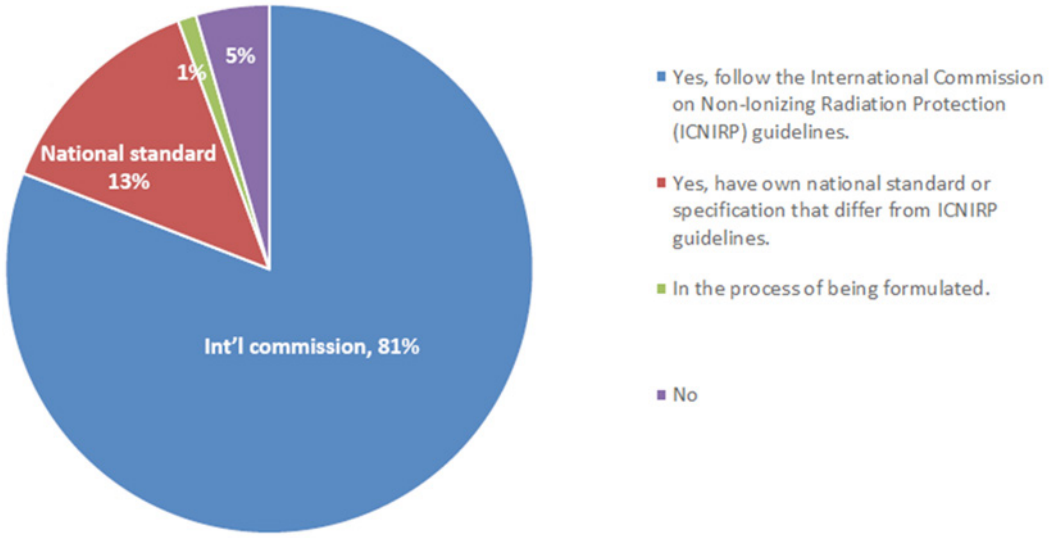
Abbreviation/acronym	Description
MSIP	The Ministry of Science, ICT and Future Planning (Republic of Korea)
NIR	Non-Ionizing Radiation
NMIAH	National Media and Infocommunications Authority of Hungary
NRIRR	National Research Institute for Radiobiology and Radiohygiene
PD	Power Density
P-MP	Point to Multi Point
PP	Plenipotentiary Conference (ITU)
RAN	Radio Access Network
RF	Radio Frequency
RRA	Radio Research Agency (Republic of Korea)
SAR	Specific Absorption Rate
SC	Safety Code (Health-Canada)
SCENIHR	Scientific Committee on Emerging and Newly Identified Health Risks
SCHEER	Scientific Committee on Health, Environmental and Emerging Risks
SDO	Standard Development Organization
SSC	Smart Sustainable Cities
UHF	Ultra High Frequency (300-3,000 MHz)
UMTS	Universal Mobile Telecommunication System
USD	US Dollar
VHF	Very High Frequency (30-300 MHz)
WHO	World Health Organisation
Wi-Fi	Wireless Fidelity (IEEE)
WLAN	Wireless Local Area Networks
WTDC	World Telecommunications Development Conference (ITU-D)
WTSA	World Telecommunications Standardisation Assembly (ITU-T)

Annexes

Annex 1: Survey on strategies and policies concerning human exposure to EMF

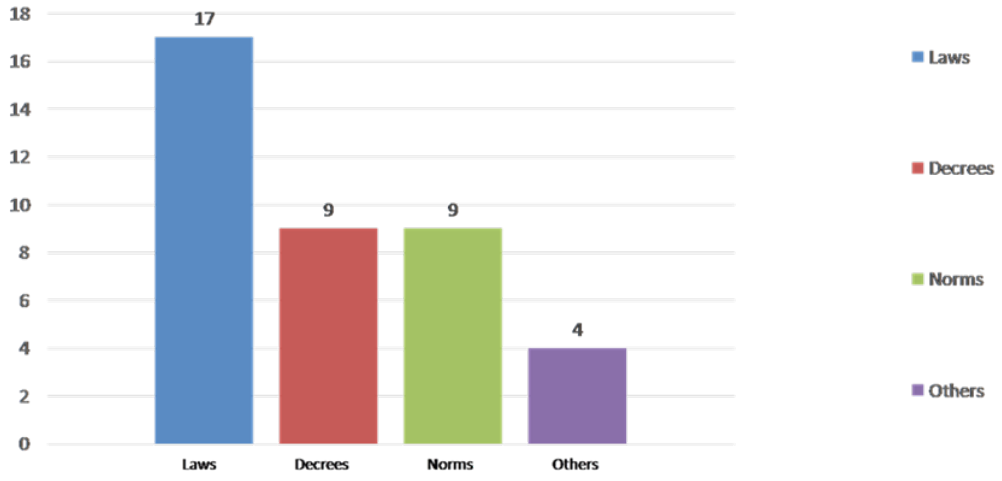
1. Does your country have a standard or specification that determines the exposure limits?

Figure 1A: Does your country have a standard or specification that determines the exposure limits?



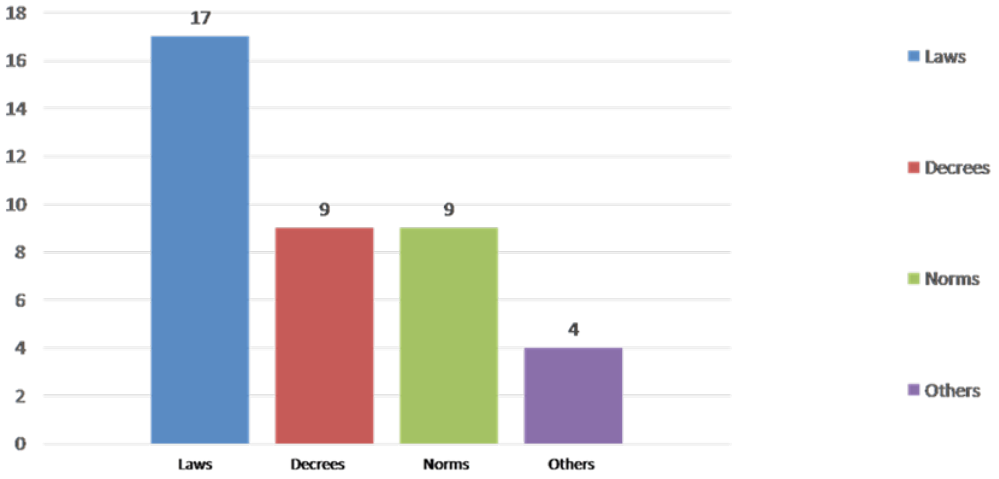
2. Which type of legislation and/or regulation exists in your country?

Figure 2A: Which type of legislation and/or regulation exists in your country?



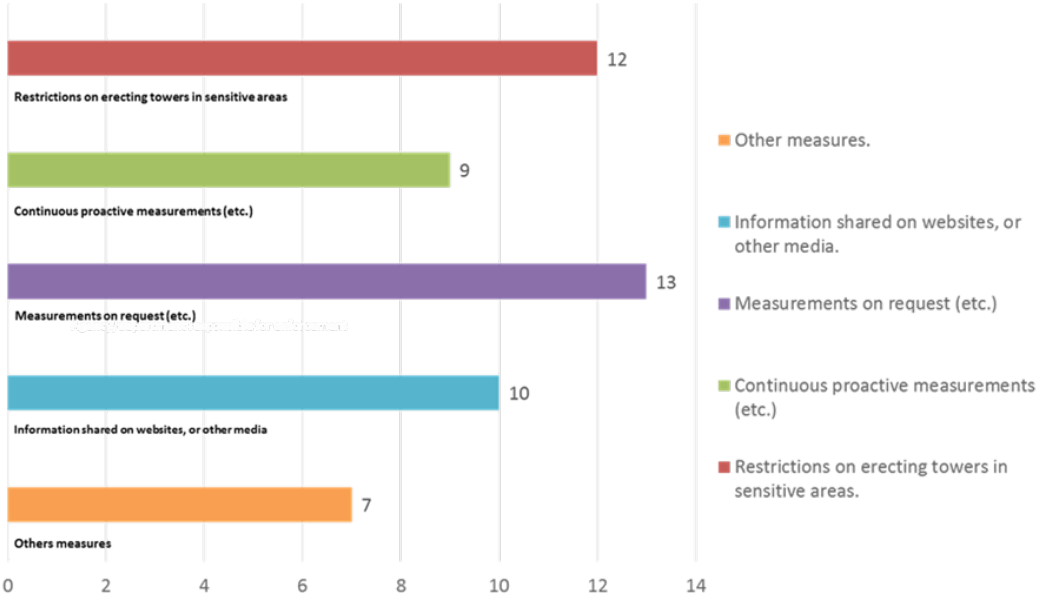
3. What kind of organizational structure of responsible authorities exists in your country?

Figure 3A: What kind of organizational structure of responsible authorities exists in your country?



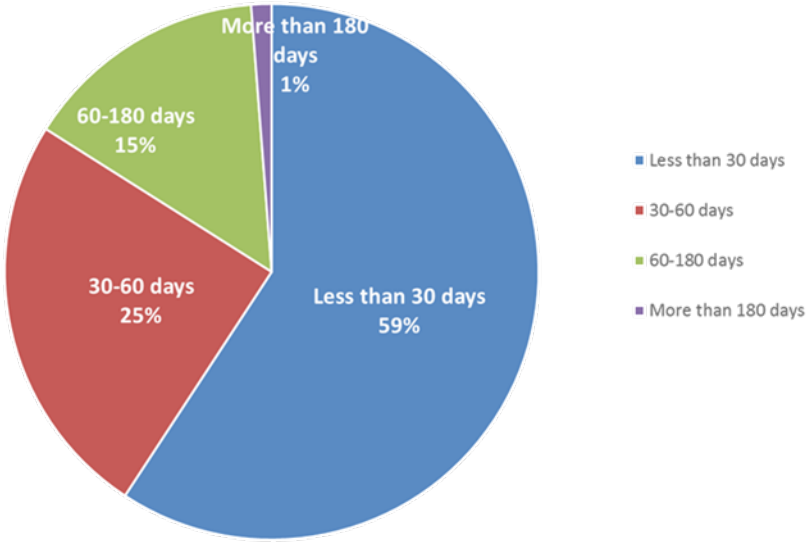
4. What kind of measures are taken with consideration to possible sensitive areas (schools, hospitals, etc.) and vulnerable populations (pregnant women, children, etc.)?

Figure 4A: What kind of measures are taken with consideration to possible sensitive areas (schools, hospitals, etc.) and vulnerable populations (pregnant women, children, etc.)?



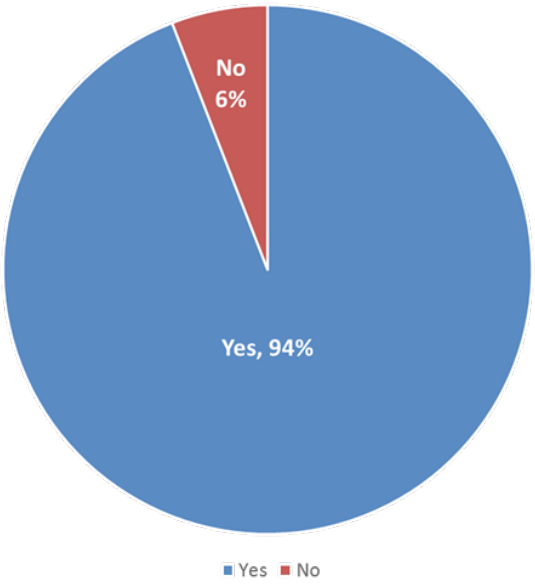
5. What is the approximate timeframe to assess a radiocommunication site?

Figure 5A: What is the approximate timeframe to assess a radiocommunication site?



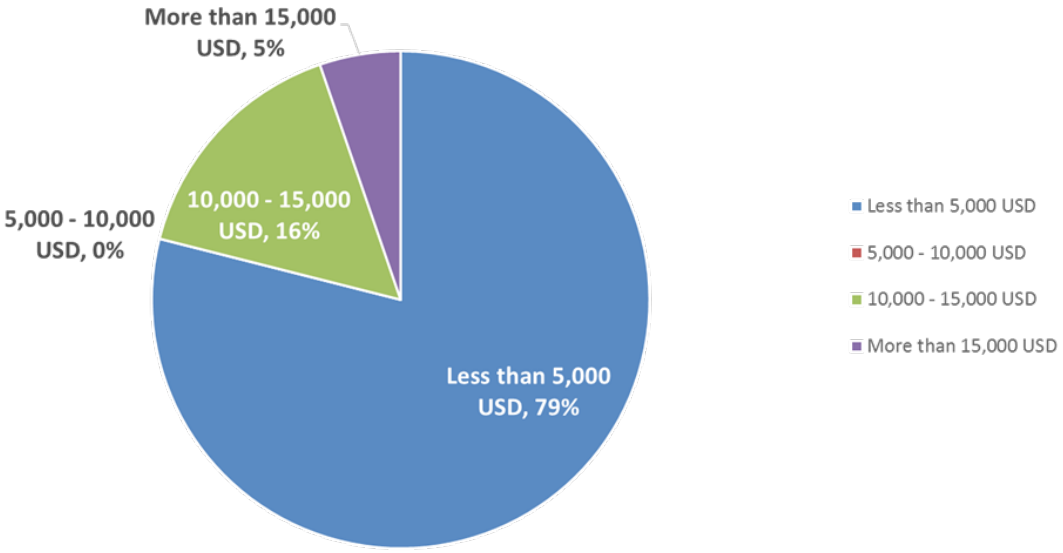
6. Is the time frame specified in a law/decree/norm/guidelines, etc.?

Figure 6A: Is the time frame specified in a law/decree/norm/guidelines, etc.?



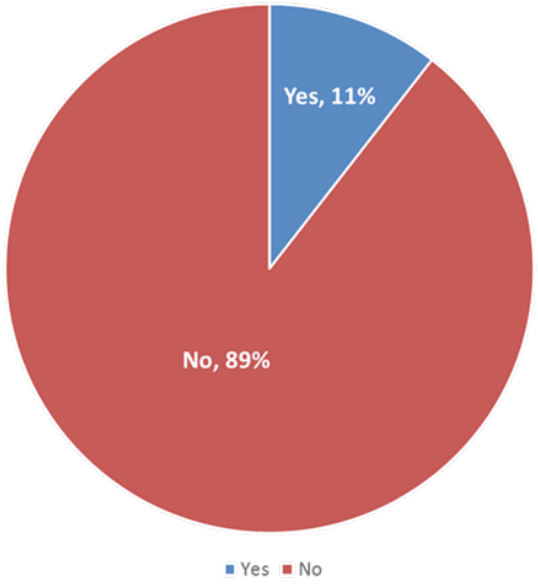
7. What is the approximate expense of assessing a conventional (used in populated areas) radiocommunication site?

Figure 7A: What is the approximate expense of assessing a conventional (used in populated areas) radiocommunication site?



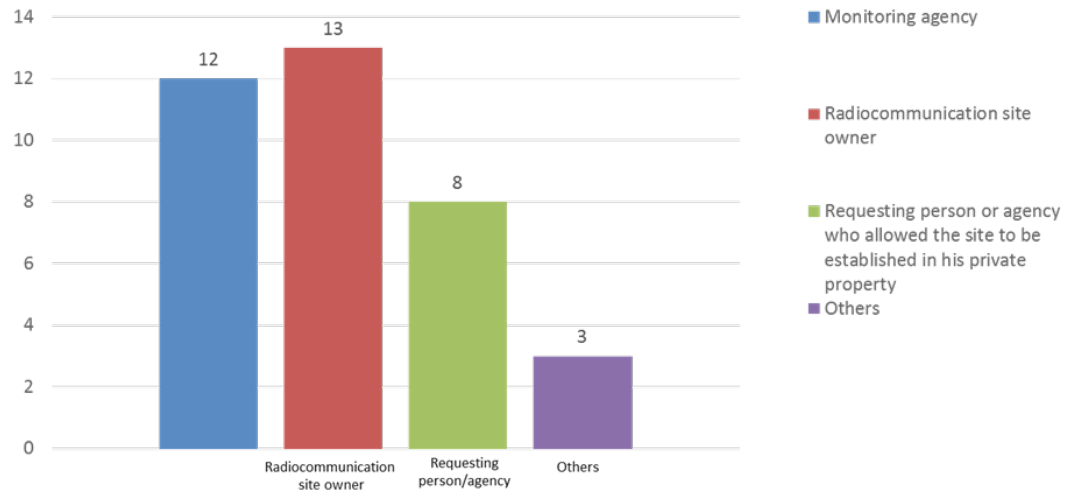
8. Are such expenses specified in a law/decree/norm/guidelines, etc.?

Figure 8A: Are such expenses specified in a law/decree/norm/guidelines, etc.?



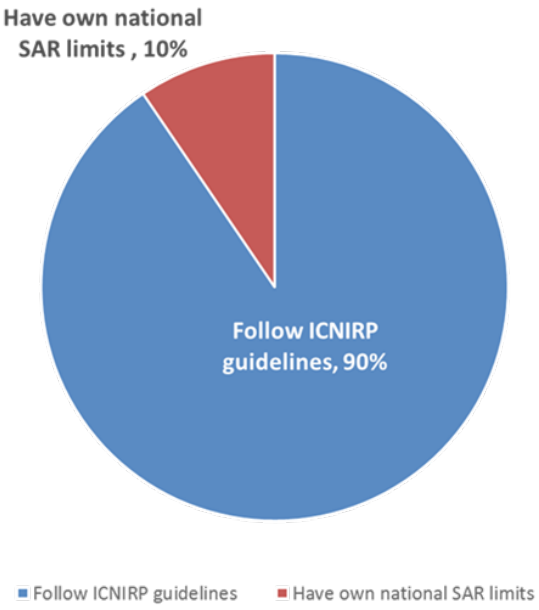
9. Who will pay for the assessment of a radiocommunication site?

Figure 9A: Who will pay for the assessment of a radiocommunication site?



10. What is the Specific Absorption Ratio (SAR) limit for mobile terminals in your country?

Figure 10A: What is the Specific Absorption Ratio (SAR) limit for mobile terminals in your country?



11. Is there any special legislation and/or regulation for the deployment of radiocommunication infrastructures in your country? If yes, please specify.

Figure 11A: Is there any special legislation and/or regulation for the deployment of radiocommunication infrastructures in your country? If yes, please specify.

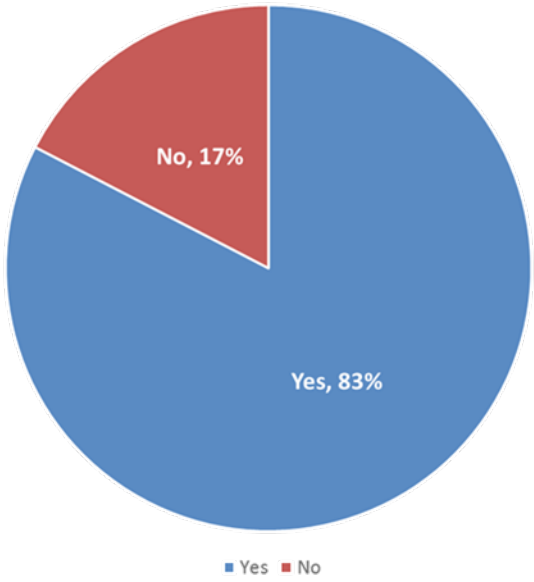
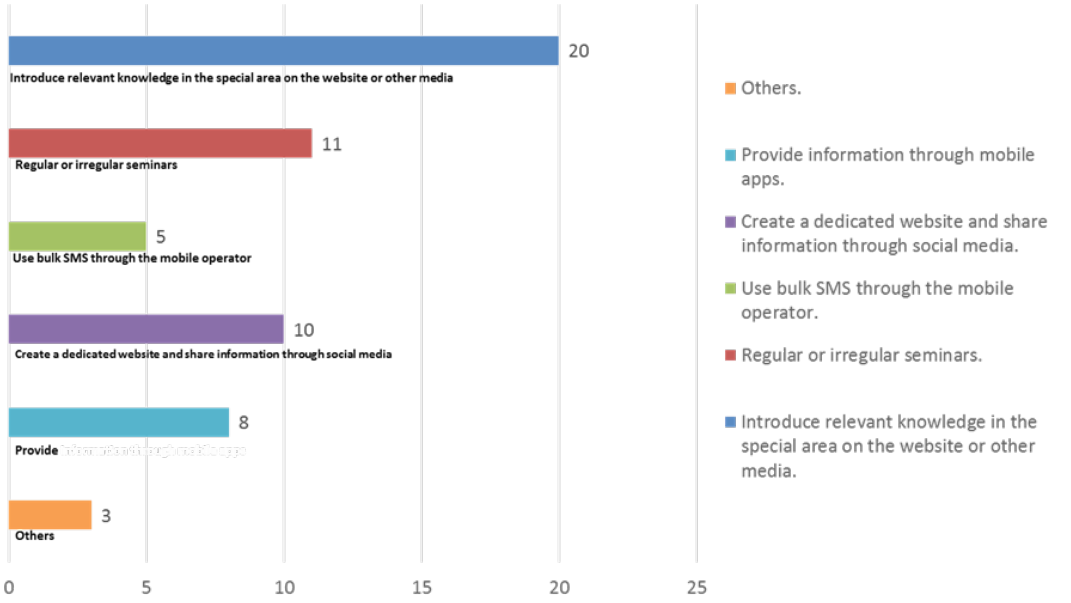


Figure 12A: Detailed answers related to special legislation and/or regulation for the deployment of radiocommunication infrastructures in countries.

Israel	1996 law on non-ionzed exposure; see http://www.infocell.org/imgs/uploads/law.pdf and 2009 decrees
Chile	Norma: Ley 18168 de Chile
United Kingdom	There is planning policy guidance: http://www.mobilemastinfo.com/planning-policy/planning-policy-and-practice.html And a Code of Best Practice on Mobile Network Development in England. http://www.mobilemastinfo.com/best-practice/mobile-operators-code-of-best-practice-article.html
Uruguay	Normas de la URSEC y de las Intendencias.Hay varias. Tienen que ver desde el punto de vista de impacto ambiental, zonas prohibidad, limitación de emisiones radioeléctricas, compartición de infraestructura, etc.
Israel	Planning and building Law
Sudan	The Telecommunications Act and relevant regulations, stipulations and policies]
Cameroon	Décision n°054/MINPOSTEL du 18 avril 2013 fixant les conditions d'installation des pylônes et des mâts à usage des télécommunications au Cameroun
Mali	L'ordonnance N°2011-023/P-RM du 28 septembre 2011.
Cameroon	La décision n° 054/Minpostel/ du 18 avril 2013 fixant les conditions d'installation des pylônes et des mâts à usage des Télécommunications au cameroun
Norway	https://lovdata.no/dokument/NL/lov/2000-05-12-36?q=strålevern
Colombia	Para el servicio de radiodifusión sonora la norma aplicable es el Plan Técnico Nacional de Radiodifusión Sonora
Armenia	Order N 933 of the Minister of Health, from 16.08.06, <>_sanitary rules and norms N 2.1.8-010-06
Kazakhstan	Communication, Informatization and Information Committee (Kazakhstan) - Law No. 567 of 5 July 2004 on communications - Government Order No. 164 of 31 January 2001 approving Rules for the development and use of public telecommunication networks, and resources for a single telecommunication network for the requirements of state bodies, defence, security and law enforcement authorities of the Republic of Kazakhstan - Government Order No. 543 of 21 May 2002 approving the Rules of the Interagency Radiofrequency Commission of the Republic of Kazakhstan - Government Order No. 932 of 21 August 2002 concerning certain questions pertaining to the use of the radio frequency spectrum by the Republic of Kazakhstan - Government Order No. 451 of 31 March 2009 approving the list of universal telecommunication services and Rules for subsiding the cost of universal telecommunication services - Government Order No. 990 of 27 June 2009 approving Rules for converting radio frequency spectrum and methods for establishing the technical and economic basis of expenditure on converting radio frequency spectrum
Australia	In Australia, the rollout of new free standing towers are subject to State and local government planning laws. This gives communities a say on construction projects in their area. State government and local planning laws set out requirements for community consultation. In addition, Schedule 3 of the Telecommunications Act 1997 affords carriers special powers and immunities to rollout certain facilities without undergoing a local or state government planning process. These facilities are listed in the Telecommunications (Low-impact facilities) Determination 1997 (LIFD) and fall within strict type, size, colour and location limitations. The LIFD encourages carriers to rollout infrastructure that has minimal the impact of on the community while also expediting the supply of services. (https://www.comlaw.gov.au/Details/C2015C00540/Html/Text https://www.comlaw.gov.au/Details/F2004C01082) Facilities installed under the LIFD are required to comply with the Industry Code for Mobile Phone Base Station Deployment, which imposes consultation requirements similar to local government processes. The Telecommunications Code of Practice 1997 sets out further obligations on carriers. In this way, communities are still given an opportunity for consultation. (http://www.acma.gov.au/theACMA/industry-code-mobile-phone-base-station-deployment, https://www.comlaw.gov.au/Details/F2004C01081)
State of Palestine	Telecommunication Act No. 3 (1996); Telecommunication Regulation No. 1 (1996); Licensing agreement signed with the Palestinian Telecommunication Company (1996); Interconnection instructions.
Benin	Référence : Décret N° 2015-490 DU 07 Septembre 2015 portant protection des personnes contre les effets des champs électriques, magnétiques et électromagnétiques de 0 à 300 GHz. Lien : http://arcep.bj/textes-juridiques/decrets/
Hungary	If the antenna mast does not exceed 6 meters tall and any size of the antenna construction does not exceed 4 meters, the radiocommunication infrastructure can be operated without any construction permission. However in such a case the radiolicense holder must enclose a declaration to the deployed application that include a calculation proving the radiation is below the helath reference level in public places.
Bolivia (Plurinational State of)	Viceministerio de Telecomunicaciones Normas municipales de autorizacion de instalacion de torres y soportes de antenas y redes de telecomunicaciones.
Brazil	Federal Law n° 11934/2009 Anatel Resolution n° 303/2002

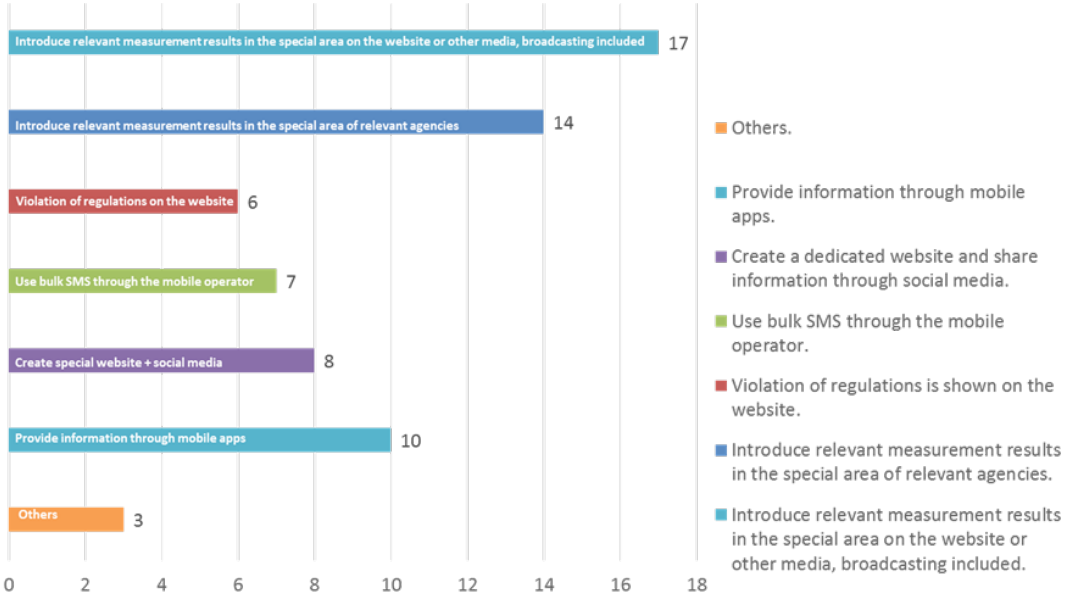
12. What constitute some good practices on how to raise the awareness in the population/country on issues concerning human exposure to electromagnetic fields?

Figure 13A: What constitute some good practices on how to raise the awareness in the population/ country on issues concerning human exposure to electromagnetic fields?



13. What constitute some good practices on how to bring the exposure information to the attention of the population?

Figure 14A: What constitute some good practices on how to bring the exposure information to the attention of the population?



14. Does your country enforce obligations for radiocommunication site owners? If others, please specify: 13 responses.

Figure 15A: Does your country enforce obligations for radiocommunication site owners?

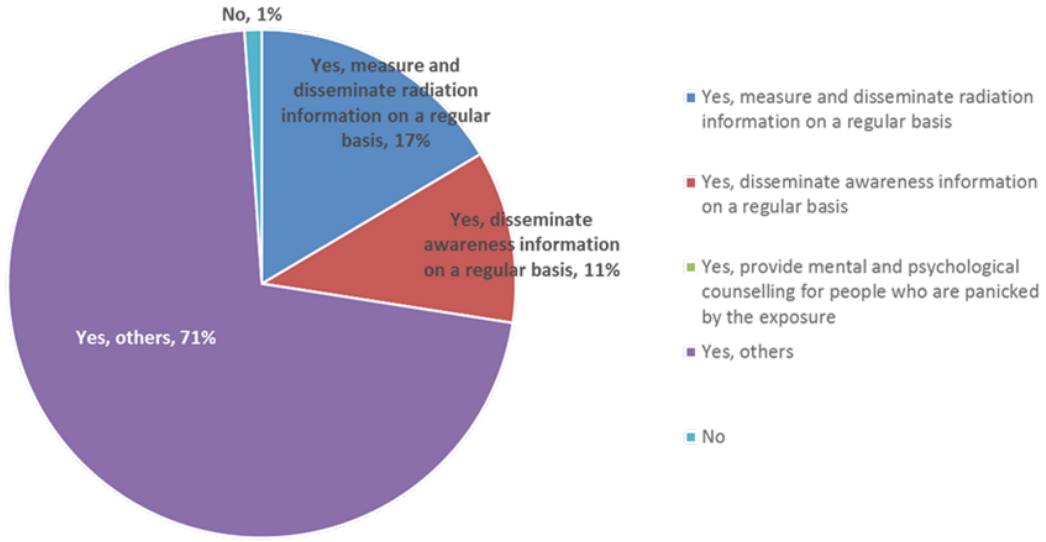


Figure 16A: Detailed answers related to obligations for radiocommunication site owners.

- **Chile** *SERMECOOP* Están indicadas en la Norma: Ley 18168 de Chile
- **United Kingdom** *GSM Association (International)* There is a voluntary approach to community engagement as set out in the Code of Practice and operator voluntary
- **Sudan** *National Telecommunications Corporation (NTC) (Sudan)* Adherence to NTC specifications, stipulations and regulations
- **Cameroon** *Ministère des Postes et des Télécommunications (Cameroon)* communiquer les mesures à l'ART
- **Mali** *Autorité Malienne de Régulation des Télécommunications/TIC e (Mali)* Obligation de respect des normes CIPRNI
- **Cameroon** *Ministère des Postes et des Télécommunications (Cameroon)* mesurer les rayonnements et les Communiquer à l'ART à l'effet de justifier le respect des valeurs limites
- **Colombia** *Ministerio de Tecnologías de la Información y las Comunicaci (Colombia)* Para el servicio de radiodifusión sonora deben realizar un cerramiento al sitio de radiocomunicación para evitar el acceso al público en general
- **Armenia** *Ministry of Transport and Communication (Armenia)* Occupational health protection of employees, preventive medical examinations of employees
- **Australia** *Department of Communications and the Arts (Australia)* The Australian Communications and Media Authority (ACMA) is the regulator for EME issues.(http://www.acma.gov.au/)
- **State of Palestine** *Ministry of Telecommunications & Information Technology (State of Palestine)* For example, making the necessary modification to the station, if the permitted limit is exceeded.
- **Hungary** *National Media and Infocommunications Authority (Hungary)* The radiolicense holder must enclose a declaration to the deployed application that include a calculation proving the radiation is below the helath reference level in public places.
- **Bolivia (Plurinational State of)** *Viceministerio de Telecomunicaciones* Realizan mediciones y presentan en el informe ambiental anual a la Autoridad Ambiental Competente. Los operadores de telecomunicaciones realizan mediciones periodicas y presentan el informe ambiental anual a la Autoridad Ambiental Competente.

Annex 2: List of contributions for ITU-D Study Group 2 and Rapporteur Group meetings directly related to Question 7/2

Inputs received for Rapporteur Group and Study Group meetings

Web	Received	Source	Title
2/444	2017-01-20	Rapporteur for Question 7/2	Report of the Rapporteur Group meeting on Question 7/2, Geneva, 20 January 2017
2/434	2017-02-22	China (People's Republic of)	Suggestions for the revision of ITU-D SG2 Question 7/2
2/428	2017-02-17	Bangladesh (People's Republic of)	Best practice strategies on raising public awareness regarding the effects of electromagnetic fields due to radio communication systems
2/425	2017-02-17	ATDI	Revision of Resolution 62: Measurement concerns related to human exposure to EMF
2/419 [OR]	2017-02-17	Rapporteur for Question 7/2	Final Report for Question 7/2
2/410	2017-02-08	ATDI (France)	Proposed revision of Question 7/2
RGQ/246	2017-01-09	ATDI	Modifications to the Draft Final Report for Question 7/2
RGQ/238	2017-01-03	Rapporteur for Question 7/2	The modification suggestions to the draft Final Report of Q7/2
RGQ/195 [OR]	2016-10-27	Rapporteur for Question 7/2	Draft Final Report for Question 7/2
2/382 [OR]	2016-09-22	Rapporteur for Question 7/2	Draft report for Question 7/2
2/372 +Ann.1	2016-09-13	Telecommunication Development Bureau	Overview of input received through the ITU-D Study Group 2 consolidated survey for Questions 6/2, 7/2 and 8/2
2/346	2016-08-31	China (People's Republic of)	Some electromagnetic radiation monitoring system related introduction in China
2/344	2016-08-31	China (People's Republic of)	The further summary and analysis of the relevant strategies and policies for human exposure to EMF in some countries
2/287	2016-07-28	ATDI	Proposed modifications to Question 7/2 report
2/263	2016-04-22	Rapporteur for Question 7/2	Report of the Rapporteur Group Meeting on Question 7/2, Geneva, 22 April 2016
RGQ/164	2016-04-22	Rapporteur for Question 7/2	Working document: draft Question 7/2 report following the 22 April 2016 Q7/2 meeting
RGQ/163 +Ann.1	2016-04-22	World Health Organization (WHO)	WHO: Electromagnetic Radiofrequency Fields National Management and Regulatory Approaches

Web	Received	Source	Title
RGQ/137	2016-04-01	China (People's Republic of)	Summary and analysis of the relevant strategies and policies for human exposure to EMF in some countries
RGQ/129	2016-03-29	ATDI	RF human hazards: ITU intersectoral activities, and exposure distances around wireless terrestrial transmitters
2/244 +Ann.1	2015-08-27	Hungary	Online Publication of the Non-Ionizing Radiation Measurement of the National Media and Infocommunications Authority of Hungary
2/235	2015-08-27	Korea (Republic of)	Regulation status and research activities on EMF Effects to human body in the Republic of Korea
2/210	2015-08-04	ITU-R Study Groups – Working Party 6A	Liaison Statement from ITU-T SG5 to ITU-D SG2 on Human exposure to RF fields from broadcast transmitters
2/208 +Ann.1	2015-07-24	G3ict	Contribution of G3ict - The Global Initiative for Inclusive Information and Communications Technologies to the Working Party 5D (WP 5D) - IMT System
2/201	2015-07-29	China (People's Republic of)	The further analysis of human exposure to electromagnetic fields
2/200 (Rev.1)	2015-07-29	Rapporteur for Question 7/2	Revised Work plan for Question 7/2
2/199	2015-07-28	Rapporteur for Question 7/2	Questionnaire for strategies and policies concerning human exposure to electromagnetic fields
2/147	2015-07-12	ITU-R Study Group 1	Liaison Statement from ITU-R SG1 to ITU-D SG2 Question 7/2 on liaison activities with CENELEC
RGQ/77 +Ann.1	2015-04-30	World Health Organization	WHO International EMF Project
RGQ/66	2015-04-13	China (People's Republic of)	Strategies and policies concerning human exposure to electromagnetic fields
RGQ/51 +Ann.1	2015-03-17	BDT Focal Point for Question 7/2	Electromagnetic Fields (EMF) regulations for broadcasting installations
RGQ/11	2014-12-15	Rapporteur for Question 7/2	Draft work plan for Question 7/2
2/94	2014-09-10	China (People's Republic of)	Proposed draft work plan for Question 7/2
2/83 +Ann.1	2014-09-07	BDT Focal Point for Question 7/2	EMF
2/53	2014-08-28	China (People's Republic of)	Study proposal on strategies and policies concerning human exposure to electromagnetic fields
2/34	2014-08-05	Telecommunication Standardization Bureau	Draft technical report on EMF Considerations in Smart Sustainable Cities

Web	Received	Source	Title
2/25 +Ann.1	2014-07-22	Switzerland (Confederation of)	Protection against non-ionizing radiation (NIR) – Regulatory policy of Switzerland

Liaison Statements (LS)

Web	Received	Source	Title
RGQ/211	2016-11-24	ITU-R Study Groups	Liaison Statement from ITU-R Working Party 5C to ITU-D SG2 on ongoing collaboration
RGQ/197	2016-10-27	ITU-T Study Group 5	Liaison Statement from ITU-T Study Group 5 to ITU-D Study Group 2 (Question 7/2) on Information about work that is being carried out within work under study in ITU-T Q7/5
2/350	2016-09-09	ITU-R Study Group 1	Liaison Statement from ITU-R SG1 to ITU-D SG2 on Question ITU-R 239/1- Electromagnetic field measurements to assess human exposure
2/282	2016-07-20	ITU-R Study Group 1	Liaison Statement from ITU-R Study Group 1 to ITU-D Study Group 2 on WHO: Fundamental Safety Principles for protection against non-ionizing radiation
2/273	2016-05-25	ITU-R Working Party 5A, 5B and 5C	Liaison Statement from ITU-R Working Party 5A, 5B and 5C to ITU-D SG2 on Human exposure to Electromagnetic Fields (EMFs)
2/272	2016-05-18	ITU-T Study Group 5	Liaison statement from ITU-T Study Group 5 to ITU-D Study 1 and 2 on updates on ITU-T SG 5 activities relevant to ITU-D study groups
2/271	2016-04-28	ITU-T Study Group 5	Liaison Statement from ITU-T Study Group 5 to ITU-D SG2 on Information about work that is being carried out within work under study in ITU-T Q7/5
RGQ/118	2016-03-09	ITU-R Study Groups – WP 5D	Liaison statement from ITU-R WP 5D to ITU-D SG2 Q7/2 on information about work that is being carried out within work under study in ITU-T Q7/5 (Human Exposure to Electromagnetic Fields (EMFs) due to radio systems and mobile equipment)
RGQ/101	2016-02-04	ITU-R Study Groups – Working Party 6A	Liaison Statement from ITU-R SG6 WP6A to ITU-D SG2 Q7/2 on establishment of Rapporteur Group on RF hazard issues
RGQ/90	2015-11-24	ITU-T Study Group 5	Liaison Statement from ITU-T SG5 to ITU-D SG2 on comments to the WHO Monograph on Radio Frequency fields: Environmental Health Criteria, Chapter 2 on Sources, measurements and exposures and Chapter 3 on Radiofrequency Electromagnetic Fields Inside The Body
RGQ/89	2015-11-24	ITU-T Study Group 5	Liaison Statement from ITU-T SG5 to ITU-D SG2 on comments to the ICNIRP documents
RGQ/88	2015-11-24	ITU-T Study Group 5	Liaison Statement from ITU-T SG5 to ITU-D SG2 on Information about work that is being carried out within work under study in ITU-T Q7/5

Web	Received	Source	Title
RGQ/33	2015-03-03	ITU-T Study Group 5	Liaison Statement from ITU-T Study Group 5 to ITU-D Study Group 2 on the Executive Summary of the ITU-T Study Group 5 Meeting
RGQ/29	2015-02-25	ITU-R Study Group 6	Liaison Statement from ITU-R Study Group 6 to ITU-D Study Groups on Radiated disturbances from PLT and wired telecommunication systems
RGQ/26	2015-02-20	ITU-R Study Groups – Working Party 6A	Liaison Statement from ITU-R Study Groups WP6A to ITU-D Study Groups on Human exposure to RF fields from broadcast transmitters
RGQ/23	2015-02-10	ITU-T Study Group 5	Liaison Statement from ITU-T Study Group 5 to ITU-D Study Group 2 on comments to the WHO Monograph "Radio Frequency fields: Environmental Health Criteria, Chapter 2: Sources, measurements and exposures"
RGQ/22	2015-02-09	ITU-T Study Group 5	Liaison Statement from ITU-T Study Group 5 to ITU-D Study Group 2 Question 7/2 concerning Q7/2 work items for the 2014-2018 study period (reply to ITU-D SG 2- Document 2/113)
RGQ/3 (Rev.1)	2014-11-18	ITU-T Focus Group on SSC	Liaison Statement from ITU-T Focus Group on Smart Sustainable Cities (FG-SSC) on Activities of the Focus Group on Smart Sustainable Cities
2/36	2014-08-06	ITU-T Study Group 5	Liaison Statement from ITU-T Study Group 5 to ITU-D SG2 Question 7/2 with Information about work that is being carried out within work under study in ITU-T Q7/5
2/14	2014-01-17	ITU-T Study Group 5	Liaison Statement from ITU-T Study Group 5 to ITU-D Study Group 1 Question 23/1 on human exposure to EMF
2/6	2013-09-13	ITU-R Study Groups – Working Party 1C	Liaison Statement from ITU-R Working Party 1C to ITU-D SG1 and ITU-T SG5 on human exposure to electromagnetic fields

Annex 3: Bibliography

ICNIRP 1998: Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), 1998.

ITU-R Handbook on Spectrum Monitoring, section 5.6 on “Non-ionizing radiation measurements”, 2011.

ITU: EMF Guide, 2014.

ITU-D Report on Question 23/1: Strategies and policies concerning human exposure to electromagnetic fields.

Health Canada: Canada Safety Code Radiofrequency Exposure Guidelines, 2015.

Mazar: Radio Spectrum Management: Policies, Regulations and Techniques. Chapter 9: RF Human Hazards, 2016.

Mazar: Human Radio Frequency Exposure Limits: an update of reference levels in Europe, USA, Canada, China, Japan and Korea; EMC Europe Wroclaw, 2016.

Potential health effects of exposure to electromagnetic fields (EMF), SCENIHR Opinion, Brussels, 2015.

Annex 4: Information available related to exposure to EMF in some European countries

Bosnia:	http://rak.ba/bos/
Croatia:	http://narodne-novine.nn.hr/clanci/sluzbeni/2011_08_98_2036.html
Denmark:	https://www.retsinformation.dk/forms/r0710.aspx?id=29325
Estonia:	https://www.riigiteataja.ee/akt/163816
Finland:	http://ec.europa.eu/enterprise/sectors/electrical/documents/emc/legislation
France:	http://www.anfr.fr/fileadmin/mediatheque/documents/expace/Anfr_BrochureGenerale_pap_0411.pdf
Greece:	http://www.eeae.gr
Hungary:	http://www.njt.hu/cgi_bin/njt_doc.cgi?docid=84814.118610
Ireland:	http://www.comreg.ie
Israel:	http://www.sviva.gov.il/subjectsEnv/Radiation/Pages/Cellular_Facilities.aspx
Liechtenstein:	http://www.avw.llv.li/
Romania:	http://www.ancom.org.ro
Slovakia:	http://www.uvzsr.sk/docs/leg/534_2007_elmag_ziarenie.pdf

Annex 5: European Commission's Scientific Steering Committee (SCENIHR)

The Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)[28] provides opinions to the European Commission on emerging or newly-identified health and environmental risks and on broad, complex or multidisciplinary issues requiring a comprehensive assessment of risks to consumer safety or public health and related issues not covered by other Community risk assessment bodies. SCENIHR has published several reports related to EMF, the last report was published in 2015.[29] The main conclusions are summarized here.

The results of current scientific research show that there are no evident adverse health effects if exposure remains below the levels recommended by the EU legislation. Overall, the epidemiological studies on radiofrequency EMF exposure do not show an increased risk of brain tumors. Furthermore, they do not indicate an increased risk for other cancers of the head and neck region. Previous studies also suggested an association of EMF with an increased risk of Alzheimer's disease. New studies on that subject did not confirm this link.

Epidemiological studies associate exposure to Extremely Low Frequency (ELF) fields, from long-term living in close proximity to power lines to a higher rate of childhood leukemia. No mechanisms have been identified and no support from experimental studies could explain these findings, which, together with shortcomings of the epidemiological studies prevent a causal interpretation.

Concerning EMF hypersensitivity (idiopathic environmental intolerance attributed to EMF), research consistently shows that there is no causal link between self-reported symptoms and EMF exposure.

[28] Its work is now undertaken by the Scientific Committee on Health, Environmental and Emerging Risks (SCHEER).

[29] Potential health effects of exposure to electromagnetic fields (EMF), SCENIHR Opinion, Brussels, 2015.

Annex 6: Case studies

The relationship between brain cancer and the introduction of mobile phones (Australia)

Mobile phone use in Australia has increased rapidly since its introduction in 1987 with whole population usage being 94 per cent by 2014. The study[30] explored the popularly hypothesised association between brain cancer incidence and mobile phone use, they examined age and gender specific incidence rates of 19,858 male and 14,222 female diagnosed with brain cancer in Australia between 1982 and 2012, and mobile phone usage data from 1987 to 2012.

Age adjusted brain cancer incidence rates rose slightly over time in males but not in females. In 2012, rates were about 50 per cent higher in males than in females.

Conclusion:

After nearly 30 years of mobile phone use in Australia among millions of people, there is no evidence of any rise in any age group that could be plausibly attributed to mobile phones.

Radiofrequency fields and health (Canada)

Radiofrequency (RF) energy or fields are a part of everyday life. They are produced by sources such as radio and television broadcasting, mobile radiocommunication transmitting facilities, cell phones and radar.

The remarkable growth of radiofrequency technology over the last few years has raised public concerns about possible associations between RF energy and adverse health outcomes. Canada, in fact, was one of the first industrialized countries to recognize the need for RF exposure guidelines. Health Canada developed its first RF exposure limit guideline, known as Safety Code 6, in 1979. Since then, Safety Code 6 has been updated several times with the most recent revision in 2015. The exposure limits outlined in Safety Code 6 are set far below the lowest level of RF exposure that could produce potentially harmful effects in humans. It is based on the weight of evidence, including most recent science, from hundreds of peer-reviewed RF studies. It has been reviewed and recommended by independent third parties such as the Royal Society of Canada; and its limits, based on established biological effects, are among the most stringent in the world. http://www.hc-sc.gc.ca/ewh-semt/radiation/cons/radiofreq/index-eng.php.

Electromagnetic radiation online monitoring system (People's Republic of China)

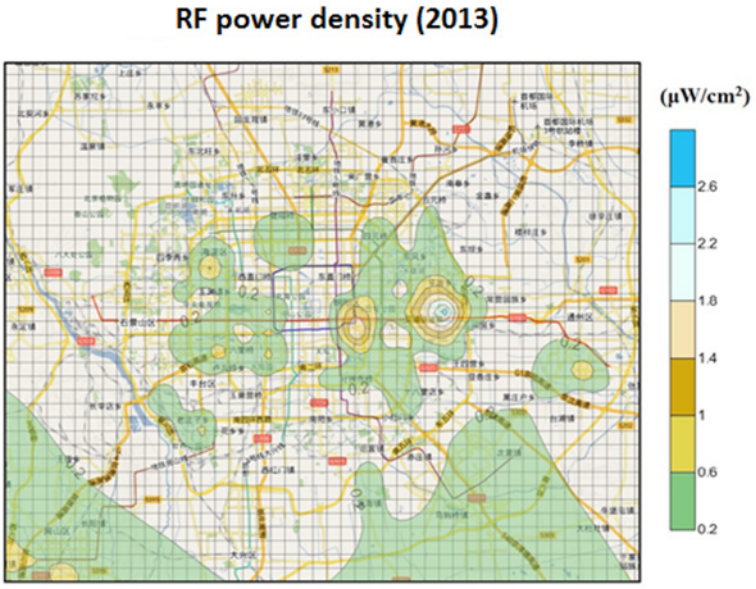
The requirements for electromagnetic radiation monitoring focus on environmental protection, power line and mobile communication fields, need online monitoring, real-time publication, and public science popularization. Based on that the electromagnetic radiation online monitoring system developed in the People's Republic of China, has the function of online monitoring, real-time transmission, and real-time publication. The data can be published through large screen displays, website, APPs, and Wechat, together with popular science on the issue.

Safetytech (a company) developed the first electromagnetic radiation monitor, frequency range from 1 to 18GHz, print the monitoring data through portable Bluetooth printer on the spot. The newest electromagnetic radiation online monitoring system implement the function through powered entirely by solar energy, wireless data transmission, and develop monitoring center software system platform, data publishing platform, etc. According to differences between erection and operation, the system is divided into base-station delicate, vehicular, moveable, unmanned aerial vehicular, and fixed electromagnetic radiation online monitoring system.

[30] Has the incidence of brain cancer risen in Australia since the introduction of mobile phones 29 years ago? Chapman et al., Cancer Epidemiology, 42(199–205) June 2016.

Investigation to the electromagnetic environment in cities needs RF information, spatial distribution information, etc. Safetytech implemented an electromagnetic environment investigation in Beijing downtown in 2013, divided the city to 352 grid point by 2km×2km, monitor each grid point center. The RF electromagnetic strength range from 0.2V/m to 6V/m, the average is 0.89V/m. The distribution of the electromagnetic environment in Beijing as shown in **Figure 17A**.

Figure 17A: The distribution of the electromagnetic environment in Beijing



Online publication of the non-ionizing radiation measurement (Hungary)

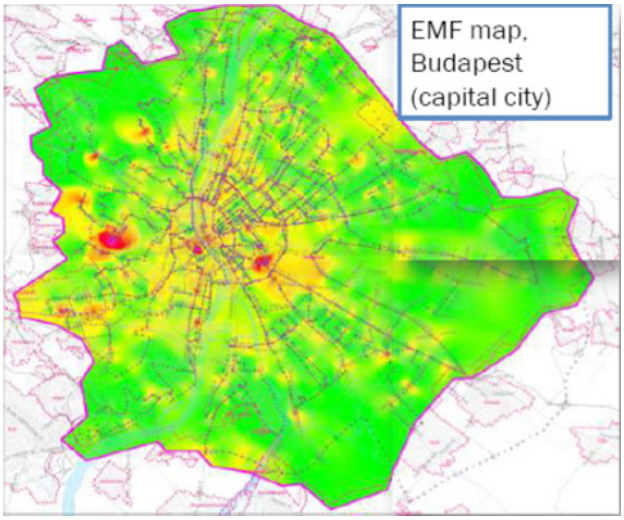
The health aspects of electromagnetic radiations in Hungary were within a specialised institution – National Research Institute for Radiobiology and Radiohygiene (NRIRR) of the National Public Health Service. Among their duties they take part in the licensing of the construction of radio facilities and carry out individual measurements. However, because of capacity and expertise, the National Media and Infocommunications Authority of Hungary (NMIAH) installed a national EMF monitoring and information network in agreement with the NRIRR.

The measurement programme involves collecting data using twenty five (25) area monitoring instruments by moving them to new locations every two weeks. Measurements spots were selected educational institutions, nurseries and schools situated close to radio facilities. Tests are also carried out occasionally on requests by private individuals.

On the bases of the former work, Hungary expanded measuring activities, like, continuous programs in public places, testing new/specific stations, and path-registered measurements. Hungary also developed versatile web-publication, like, statistics between individual measurements, results of single handheld measurements, ranked results, different sites for each measurement programs, path-registered measurements, and application form for programs and web analytics.

Figure 18A shows the most cases the level of measured field is lower than 0.2V/M (green). High blocks of flats have lots of antennas, also some mobile base stations (yellow). The highest level of EMF field coming from broadcast stations (bigger red areas). Mobile base stations on lower building can cause higher field in small area (small red points).

Figure 18A: The EMF map



Regulation and research on EMF effects to human body (Republic of Korea)

All the radio facilities shall be installed in accordance with the safety installation standards to ensure that they do not harm the human body or damage other facilities. The Ministry of Science, ICT and Future Planning (MSIP) is responsible for EMF regulations in Korea except the EMF coming from power lines, which is regulated by the Ministry of Trade, Industry and Energy (MOTIE). The MSIP shall establish the EMF exposure limits and the related measurement methods, the ministry also needs to establish the devices and installations subject to the EMF limits, and rating and labeling method.

The manufacturer, the importer and the installer or owner of radio facilities shall ensure that the radio facilities comply with the EMF exposure limits, and the installers shall install safe facilities in keeping a safety distance if necessary. The owners of each radio stations shall report the EMF test result for the radio stations to the MSIP. The MSIP may order the installer to set up safe facilities or to restrict/stop the operation of the radio facilities if it does not comply with the EMF human exposure limits.

The National Radio Research Agency (RRA) is in charge of the measurement related standards and certification system as a certification body. The measurement methods for electromagnetic field strength and SAR are prescribed in RRA Notifications. The EMF rating and labeling system has been enforced since August 1, 2014, which were required by the MSIP Notification. The operators of radio stations should put the rating labels of EMF strength of the radio station by applying the exposure criterion indicated at an appropriate place. For portable devices, which are used in contacting the user's ear, the manufacturers or importers of the devices should affix the SAR rating labels to the products, and/or display the measured highest SAR values in the manual.

The public concerns for the EMF are very high in the Republic of Korea. Around 400-500 public appeals regarding the electromagnetic field radiation from base stations are submitted to administrations and operators every year. Government and operators deal with the complaints and offer proper answers and related information which are based on scientific evidence. Regarding the power lines and substations, about 170 complaints have been filed to Korea Electric Power Corporation (KEPCO) recently. KEPCO deals with the complaints actively to lessen the public concern for the power line EMF.

Two projects "A study on the EMF exposure control in smart society" and "A study on health effects and protection of EMF" were launched in 2013, and were merged into a new project this year, which was funded by the MSIP. The project has been conducted under the superintendence of Electronics and Telecommunications Research Institute (ETRI) in collaboration with several universities and academic societies (e.g., Korean Institute of Electromagnetic Engineering and Science). The project title is "A Study on the EMF Exposure Control in Smart Society".

Relationship between tumors in the head and frequent long mobile phone calls (The Netherlands)

With the fast increase of mobile telecommunication and wireless internet also concern is growing. The Health Council of the Netherlands closely follows the scientific literature on exposure to radiofrequency fields.[31] It has not been proven that making frequent long-term mobile phone calls leads to tumors in the head. For the current report the council has systematically evaluated both the epidemiological and animal experimental data and explicitly considered the quality of the studies.

According to the Health Council, there is no established association between long-term and frequent use of a mobile telephone and an increased risk for tumors in the brain or head and neck area. However, such association can also not be excluded, but the council considers it unlikely.

Suggestion:

a) Keep exposure as low as reasonably possible, although there's no reason for measures to reduce exposure. For instance, it is not necessary for equipment to emit electromagnetic fields with a larger power or during a longer time period than necessary for a good connection.

b) It's important that ongoing studies into long-term health effects of the use of mobile telephones be continued, particularly because the exposure to radiofrequency fields continuously changes as the result of changes in the use and the development of new mobile telecommunication devices.

Health effects of non-ionizing fields (New Zealand)

Applications and uses of technology incorporating radio transmitters have burgeoned over the past few years and are likely to continue to do so. Many new devices communicate over cellular phone networks or Wi-Fi, and networks using these technologies have expanded considerably. Several health and scientific bodies have periodically reviewed recent research, and findings from these are summarized in the report.[32]

Conclusion:

a) While a great deal of research has been carried out to investigate the potential effects of exposures to RF fields on health, particularly exposures associated with cellphone use, there are still no clear indications of health effects caused by exposures that comply with the limits in the New Zealand RF field exposure standard.

b) Although the research on cellphone use and brain tumours resulted in RF fields being classified as a 'possible' carcinogen by IARC, several reviews and meta-analyses published since the IARC assessment consider that more recent research weighs against there being a cause and effect relationship, and the complexity of the existing data and difficulties in making further progress have also been highlighted.

c) Recent dosimetry work has found that at some frequencies the reference levels in the New Zealand standard are not as conservative as expected, and that under some circumstances the basic restriction may be exceeded when small children are exposed to fields that are close to the reference level. This is not of immediate concern for two reasons: measurements in New Zealand show that exposures in areas where children might be expected are always very small fractions of the reference level (so the basic restriction will never be exceeded), and the amount by which the basic restriction might be exceeded is small in comparison to the safety factor of 50 built into the basic restriction.

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31 https://www.gezondheidsraad.nl/en/publications/gezonde-leefomgeving/mobile-phones-and-cancer-part-3-update-and-overall-conclusions.

32 http://www.health.govt.nz/publication/interagency-committee-health-effects-non-ionising-fields-report-ministers-2015.

Radiofrequency electromagnetic field exposure levels (Spain)

The enormous popularity of mobile telephony in recent years has not only meant a major technological revolution, but has also produced a highly significant transformation from a social, economic and environmental point of view. Never before in the history of humanity has the appearance of a new technology been so widely accepted by society in such a short space of time.

The construction of towers with television and radio antennae on hilltops has enabled society to enjoy these services for decades. Mobile phones, unlike radio and television, require antennae closer to the users, in order to offer quality mobile voice and data services. As a result of public concern, the deployment of mobile phone antennae has suffered difficulties, particularly as a result of the pressure by the local councils. Aware of this problem, the European Parliament, in Resolution 32008/2211 (INI), among other aspects, encouraged service providers, public authorities and citizens associations to find mutually acceptable solutions with respect to the deployment of mobile phone antennae. In addition, in order to guarantee information to the public on the matter, it called for Member States to publish maps showing electromagnetic field exposure levels, and suggested that these maps be made available online for consultation. The government of Catalonia has implemented a system and produced reports[33] on the exposure levels.

Protection against non-ionizing radiation (Switzerland)

The Swiss government has put into force a new ordinance on the protection of the general population from Non-Ionizing Radiation (NIR) originating from stationary installations. No restrictions are imposed on mobile equipment like cellular phones or electric appliances because emission reducing strategies for such consumer products must be standardized at the international level. Swiss enforces the reference levels for the general population which were recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). In addition emphasis is given to the precautionary reduction of long term exposure.

Legal framework:

The legal framework is laid down in the Swiss federal law relating to the protection of the environment. According to this law NIR in the environment must be limited to a level which is neither harmful nor a nuisance to humans. This level has to be defined in terms of exposure limit values. The basis for deriving these exposure limit values is – according to the law – the state of scientific knowledge or the general experience.

In addition exposure which might be harmful or a nuisance shall be limited in the sense of precaution as much as technology and operating conditions will allow provided this is economically acceptable. A risk needs not to be proven for precautionary measures to be implemented. The precautionary Principle approach is designed to reduce potential risks, specifically potential long term risks which, due to limited knowledge, cannot yet be assessed in a satisfactory way.

Exposure limit values:

The data base which underlies ICNIRP's 1998 reference levels is rather limited. Only short term biological effects at rather high intensity were considered by ICNIRP to be sufficiently validated. Consequently there are some doubts as to whether the ICNIRP guidelines provide the degree of protection requested by the Swiss law on environmental protection.

The Swiss limits have been reported to explain approximately 30 per cent of the increasing cost of deploying networks compared to countries adopting the ICNIRP levels. If Switzerland were to adopt the ICNIRP limits it would require 21.5 per cent fewer antenna sites compared to the existing regulations.

[33] http://governancaradioelectrica.gencat.cat/documents/10180/d2f1e114-a4a0-4c69-852e-e179670cd2bb.

Precautionary principle:

The principle of precaution is also focused to those situations where people are exposed for a prolonged duration. Exposure is considered long term if a source emits for at least 800 hours per year and if the radiation of this source impinges on a place where human can stay for a prolonged time. The latter places are called “places of sensitive use”.

Human exposure to radio frequency fields from broadcast transmitters (United Kingdom)

The work described is concerned with measurement strategies and methods, and carried out in the United Kingdom of Great Britain and Northern Ireland (United Kingdom) by the British Broadcasting Corporation (BBC). Guidelines for tolerable levels for human exposure to Non-Ionizing Radiation are published by ICNIRP, Sovereign governments can, do and must set their own national standards under local health and safety arrangements. The ICNIRP guidelines form the basis for most national standards including those in the UK. However, the ICNIRP guidelines are not always applied in their entirety. Selective interpretation can sometimes (and understandably) result in national standards, guidelines and even a legal framework that is more conservative than the ICNIRP guidelines.

The BBC has been operating high power broadcast transmitters for more than 90 years with no known detrimental effects on the staff working at the transmitting sites. Indeed, anecdotal evidence suggests that beneficial effects on health and wellbeing of the typically ‘rural lifestyle’ of staff working at transmitting stations in the countryside outweighs the possible effects of radiation when compared with their colleagues in studio centres in cities. However, it is known that there are high levels of non-ionizing radiation present at and around transmitting stations. Even with a ‘clean’ health record, the BBC’s duty (of care) to staff and to members of the public who are free to approach the boundary fences of the transmitting stations requires that levels of exposure be quantified.

The initial focus of the BBC’s work was public exposure at the boundary fences of the transmitting stations. Occupational access to areas of high field strength within boundary fences is under the control of the BBC and its station operators while public access to areas outside its boundary fences is not. Radiation intensity and public exposure would have been a major consideration when the position of the boundary fences was originally set but over time a whole host of factors will have changed including the exposure guidelines themselves.

This simulation showed that in the specific situation that was modeled – an upright human standing with arms to the side or held out under plane wave ‘illumination’ – the field strength needed to induce the basic restriction SAR was in nearly all cases greater than the ICNIRP reference level; in some instances significantly so. It also showed that the vertically polarized electric field component was dominant in body heating. The body was far less sensitive to the horizontally polarized component (even with arms held horizontally out to the side) or to the magnetic field component.

Without going into details of the tests, the results showed surprisingly good correlation with the ‘Norman’ simulations. This was encouraging for two reasons. First, it gave some confidence that the technique using the computer phantom was valid and second, it opened the door to a standardized method for measurement in the field.

Conclusion:

An interesting result of the work was that the dominant field component in the near field zone was the vertical component. This, despite the fact that HF curtain antennas consist of horizontally polarized elements and in the far field generate a horizontally polarized beam. The high vertical components in the near field are mainly the result of local interaction between the elements themselves and the ancillary items. Given that an upright human body is anyway much more susceptible to the vertically polarized field, the horizontal components could realistically be ignored. Further, this means that, as with MF, ankle current measurements should give a good indication of whole body SAR.

Suggestion:

Future work might include:

a) Formalization of the 'real world' tests of the MF transmitting antennas to demonstrate correlation with the simulations.

b) Use of this work to develop and formulate a standardized measurement technique. It is suggested that a physical 'dummy' be used with electrical characteristics that allow the ankle currents in the dummy to be the same as those in a real person. Given the variability in the electrical characteristics of real humans, it would be difficult to compare results if the same person was not used in every test.

c) Further experiments to show correlation between simulated and measured ankle currents at HF.

d) Development of techniques to reduce the necessary computing overhead. Some early work using very much simplified human phantoms did not yield very good results.

Advice on exposure to EMF in Wireless networks (Wi-Fi) environment (United Kingdom)

Public Health England has produce guidelines[34] on exposure to radio signals from wireless networks Wi-Fi). Wi-Fi is the most popular technology used in Wireless Local Area Networks (WLANs). These are networks of devices and computers where communication occurs through radio waves instead of connecting cables. Wi-Fi devices must be equipped with antennas that transmit and receive radio waves in order to allow wireless connections. The devices operate in certain frequency bands near 2.4 and 5 gigahertz (GHz).People using Wi-Fi, or those in the proximity of Wi-Fi equipment, are exposed to the radio signals it emits and some of the transmitted energy in the signals is absorbed in their bodies.

There is no consistent evidence to date that exposure to RF signals from Wi-Fi and WLANs adversely affect the health of the general population. The signals from Wi-Fi are very low power, typically 0.1 watt, in both the computer and the mast (or router) and resulting exposures should be well within internationally-accepted guidelines. The frequencies used are broadly the same as those from other RF applications. Based on current knowledge, RF exposures from Wi-Fi are likely to be lower than those from mobile phones. There is no consistent evidence of health effects from RF exposures below guideline levels and no reason why schools and others should not use Wi-Fi equipment.

[34] https://www.gov.uk/government/publications/wireless-networks-wi-fi-radio-waves-and-health.

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