Before the
TELECOM REGULATORY AUTHORITY OF INDIA
New Delhi

In the matter of	)	
	)	
Consultation Paper on Spectrum related issues: efficient utilization, spectrum allocation, and spectrum pricing	)	Consultation Paper no. 11/2004

COMMENTS OF SIDDHARTHA RAJA

I hereby respectfully submit comments on the TRAI Consultation Paper no. 11/2004 on issues related to Indian spectrum policy. These comments focus most on shared spectrum commons, use of spectrum by unlicensed devices such as IEEE 802.11x, pricing, and allocation.

Please let me know if I could provide any further information or answer any questions based on the content of this submission.

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Resume

My name is Siddhartha Raja. I have a Bachelors degree in Electronics and Telecommunications Engineering from the University of Mumbai, and a Master of Science degree in Management Science and Engineering from Stanford University, USA. I am currently a PhD student at the University of Illinois at Urbana-Champaign, USA. I have also attended the Programme in Comparative Media Law and Policy at the University of Oxford, UK.

I have submitted responses to proceedings of the Federal Communications Commission of the USA, and have participated and presented papers at various conferences, such as the Telecommunications Policy Research Conference, the Pacific Telecommunications Council Conference, the Union for Democratic Communications Conference, and the International Communications Association Conference.

My research interests include spectrum policy, telecommunications infrastructure policy, science and technology policy, and social studies of information and communications systems.

I am currently involved in a research project on the development of WiFi cooperatives. This project is based at the University of Illinois' Public Policy for Advanced Communications Technologies Lab, funded by the National Science Foundation, the Oxford Internet Institute, the University of Illinois Center on Democracy in a Multiracial Society, and the Illinois Program for Research in the Humanities.

All opinions and any errors in this submission are my own.

Summary

- The TRAI should consider assigning specific bands, such as the ISM bands, for use as shared spectrum, as a spectrum commons
- The spectrum commons should be made technology neutral
- The TRAI should allow the use of approved unlicensed devices in all environments within the spectrum commons
- The spectrum commons will enhance innovation, increase spectrum utilization and efficiency, improve access to spectrum, and reduce transaction costs for users
- The unlicensed devices can be tested for compliance with the non-interference conditions specified in the ISM bands, and any other TRAI-defined conditions
- Use of approved unlicensed devices will increase penetration of such services in rural India, and also increase national technological research and development
- Currently, technologies such as WiFi and Bluetooth allow for increased access to advanced broadband services such as voice, video, and data
- The spectrum commons should be made available for use gratis, free of cost
- Protected spectrum should be allocated using market methods, such as auctions or administered incentive pricing
- The TRAI should also consider allocating non-scarce spectrum as commons

Unlicensed Devices and the Spectrum Commons

Unlicensed wireless devices consist of cordless telephones, toys, wireless LAN interfaces, and other scientific, medical, and industrial devices that are unintentional radiators. In India, these devices can operate in the following frequency bands:

- 926 – 926.5 MHz
- 2.4 to 2.4835 GHz
- 5.725-5.825 GHz[1]

Current regulations permit operation in these bands if the devices are low power radiators and presume no protection from interference, do not cause interference to other devices, and access shared spectrum only.[2] These conditions and definitions are mostly in line with the ITU recommendations for the Industrial, Scientific, and Medical (ISM) bands.[3]

Contemporary discussions of spectrum policy refer to these and other similarly defined shared spectrum bands as 'spectrum commons'.[4,5,6] Devices that use the commons are typically unlicensed, that is, the user does not need a license from the regulator before commencing use of the spectrum.

This is unlike licensed spectrum used by GSM phones, TV stations, or FM radio. We refer to the spectrum used by licensed services as 'protected spectrum'.

The TRAI Should Define Shared Spectrum or Commons

The TRAI should define the above ISM bands, especially the 2.4 and 5 GHz bands, as spectrum commons. TRAI should allow unlicensed devices to operate in them, in both indoor and out-door environments. Such an assignment will spur national development of innovative wireless technologies, create additional opportunities for access to spectrum, and make India a leader in spectrum regulation and organization. Such an assignment is only a short distance from the current TRAI recommendations.[7]

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[1] Refer Government of India, National Frequency Allocation Plan, 2002, specifically India footnotes IND47, IND 52, IND 53, IND 57, IND 58, published by the Ministry of Communications, Wireless Planning & Coordination Wing. *See* Appendix A.

[2] National Frequency Allocation Plan, India footnotes IND47, IND53, IND58

[3] Refer ITU-T Radio Regulations note S5.150, also available in the National Frequency Allocation Plan 2002, p. 63

[4] Federal Communications Commission, Spectrum Policy Task Force Report, November 2002, p. 35

[5] Faulhaber, G. R. and Farber, D. J., *Spectrum Management: Property Rights, Markets, and The Commons*, Working Paper 02-12. AEI-Brookings Joint Center, Dec 2002

[6] Benkler, Y., *The Political Economy of Commons*, Upgrade, Vol. IV, No. 3, June 2003, p. 6

[7] TRAI, *Broadband India: Recommendations on Accelerating Growth of Internet and Broadband Penetration*, April 29, 2004, p. 43

The rest of this submission discusses why the TRAI should create a spectrum commons, benefits of the commons, ways to create and then regulate, current uses, and finally answers specific questions in the Consultation Paper regarding the commons.

Why TRAI Should Create a Spectrum Commons

When the TRAI creates the spectrum commons, not only does it realize the benefits of the commons, as are discussed below, but also opens the door to higher penetration of broadband Internet, voice, video and data services in rural areas as well as in urban centers. Unlicensed devices will behave if TRAI enacts simple methods of regulation. This submission discusses this aspect later.

Apart from the benefits of higher penetration and greater access to advanced communications services, the availability of the common spectrum allows for research and development by Indian science and technology institutes. The commons method of allocation of spectrum is also the most appropriate for non-scarce spectrum. If research and development can be carried out in the SHF (greater than 3 GHz) range, India will be a leading producer of next generation telecommunications and radio communication devices.

Internationally, the usage of wireless communications devices and systems is increasing. The current TRAI consultation is an example of the need to plan to accommodate the increased demand for spectrum, and the new services that are now beginning to appear.

It is becoming increasingly clear that unorganized infrastructure such as local and co-operative WiFi networks, or in-building Bluetooth networks are in the near future. Such devices use the ISM bands to communicate wirelessly. As newer technologies like these are developed, they will attain immediate dispersion within the Indian market if we allow unlicensed operation within a spectrum commons.[8]

Benefits of the Spectrum Commons

The most widely reported benefits of the spectrum commons are those related to innovation, utilization, spectrum access, and transaction cost.[9,10]

Greater Innovation

Since the commons is available for use by potentially any person, without need to expend resources on costly licenses, it is a potential breeding ground for highly innovative and futuristic wireless communications technologies. Not only will innovative behavior occur and prosper, but also the limited availability of spectrum in the commons and the non-interference conditions set can create incentives for technologies to

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[8] *See* TRAI, *Broadband India: Recommendations on Accelerating Growth of Internet and Broadband Penetration*, April 29, 2004, p. 42-44

[9] Benkler, Y., *Some Economics Of Wireless Communications*, Harvard Journal of Law & Technology, Volume 16, Number 1, Fall 2002, p. 71-76

[10] FCC, *Spectrum Policy Task Force Report*, November 2002, p. 39-41

maximize use of spectrum and decrease interference. These technologies and the research that is involved can only improve the efficiency and performance of other wireless communications devices.

Higher Utilization

As explained above, the limited resource available in the spectrum commons can drive users and designers to increase spectrum efficiency. This will increase utilization of spectrum at an individual device level. Simultaneously, the availability of this spectrum to all *bona fide* users will increase the utilization of the spectrum in these bands tremendously. Both these effects are in line with the TRAI's and Government's aim to increase the efficiency of wireless devices, and the utilization of allocated spectrum.[11]

Increased Spectrum Access

The spectrum commons will be available to all *bona fide* devices and users. As a result, the creation of the commons increases the opportunities of access to spectrum tremendously. This is analogous to having public parks or sporting facilities, which increase the opportunities for the public to enjoy sporting activity. Not only is this a public benefit, but is also a method for the TRAI to increase teledensity and the penetration of advanced communication systems without the burden of licensing.

Lower Transaction Costs

The absence of licensing or property rights allows users to access spectrum with the least transaction costs. No definition of markets or right is necessary, and *bona fide* users will seldom attract regulator action. Thus, transaction and even administration costs are low.

Creating the Commons

The ISM bands as they are currently defined are perfect for use as shared spectrum commons. Internationally as well, regulators allow for the use of the 2.4 GHz and 5 GHz bands as spectrum commons. India will be able to achieve global frequency assignment harmonization in these bands by following such a precedent.[12] The TRAI can take a first step towards creating a spectrum commons for use by approved unlicensed devices by assignment of the ISM bands at 2.4 GHz and 5 GHz. This step is in line with the recommendations of the TRAI Task Force on Growth of Internet in the Country as well as the TRAI's own recommendations in its recent Broadband India consultation.[13,14]

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[11] TRAI Consultation Paper, Chapter 3

[12] ISM bands have been reserved for unlicensed device use in Germany, Hong Kong, Australia, United States of America, United Kingdom, Malaysia, and Japan

[13] TRAI, *Report Of Task Force On Growth Of Internet In The Country*, August 2002, p. 3

[14] TRAI, *Broadband India: Recommendations on Accelerating Growth of Internet and Broadband Penetration*, April 29, 2004, p. 47

As TRAI considers the allocation method for super high or non-scarce bands, it should consider the commons mode of allocation for such spectrum. An explanation of this suggestion is in the response to questions (xxii) and (xxiii) below.

Regulating the Commons

While all users and designers of wireless communications systems will have access to the spectrum commons, it is necessary to ensure that the actions of one user do not limit the benefits to other users. In short, we seek to minimize negative externalities in the commons.[15]

The definition of the ISM bands by the ITU and the NFAP 2002 embedded some regulations. Firstly, non-interference is a necessary feature and enforcement is essential. Devices using the commons must not interfere with other devices' operation. This is possible to enforce by approving devices, or specific types of devices for use in the commons or by defining certain etiquette rules. Here we deal more with the first.[16]

The USA has FCC Part 15 rules for unlicensed devices. The FCC Part 15 rules set "out the regulations under which an intentional, unintentional, or incidental radiator may be operated without an individual license. It also contains the technical specifications, administrative requirements and other conditions relating to the marketing of part 15 devices."[17] The FCC itself approves unlicensed devices for use by testing and certification.[18] In India, if the TRAI does not wish to burden itself with testing of such devices, it can delegate this responsibility to any one of the numerous established national research institutes or laboratories. Such an action will also allow Indian designers to develop new technologies, and not force the import of such devices from other nations.

In addition to the non-interference condition, any user of the commons agrees to the non-protection clause. This essentially means that there is no guarantee that spectrum will always be available, and that no specific protection from interference exists. In short, rights of the user are limited to the right to access to the spectrum commons given use of an approved device.

A commonly held view is that congestion or interference might increase to a level that causes failure of the commons. This rationale has been used to dissuade the use of the commons scheme of allocation. Interference or congestion does not spell the end of the

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[15] Externalities occur when one person's actions affect another person's wellbeing and the market prices do not reflect relevant costs and benefits. A negative externality arises when one person's actions harm another. *See* http://www.econlib.org/library/Enc/PublicGoodsandExternalities.html

[16] *See* Satapathy, D. P. and Peha, J. M., *Etiquette Modification for Unlicensed Spectrum: Approach and Impact*, Proceedings of the IEEE Vehicular Technology Conference, vol. 1, May 1998, pp. 272-276

[17] *See* http://www.fcc.gov/oet/info/rules/part15/part15_4_23_04.pdf or http://www.access.gpo.gov/nara/cfr/waisidx_01/47cfr15_01.html

[18] *See* FCC Part 15 rules, Section 15.29: Inspection by the Commission. For the technical specifications, see Sections 15.319 and 15.407: General technical requirements. These sections have been attached as Appendix B to this submission for the TRAI's reference.

commons.[19] In fact, interference is reducible by administrative diktat and by technical design.[20] Indeed, the non-protection feature of the commons will drive users toward implementing interference-reducing technologies and methods. Congestion is of different types, and it is only in the extreme case of unpredictable, severe congestion, that the commons might have lower utility than alternative methods of allocation.[21]

The conclusion to be drawn is that it is possible to ensure the benefits of commons accrue to the maximum number of users, with a minimum of regulation. The most important form of regulation can be the imposition of rules similar to the Part15, which will ensure minimum operating standards. The commons will then be available for wide spread deployment of innovative wireless communications services, with the least transaction costs and access fees.

The Uses of the Spectrum Commons

Apart from future benefits of implementing the commons, there are very real and current uses of the commons.

WiFi

WiFi, or the IEEE 802.11a/b/g wireless LAN standard uses the ISM bands to establish broadband links between nodes and computers. WiFi is used extensively to provide wireless local area network services, and currently almost every laptop sold around the world is configured to use WiFi-enabled devices, and log on to WiFi networks. WiFi is used to provide rural broadband Internet service around the world, including India.[22]

Bluetooth

Bluetooth is an industrial specification for wireless personal area networks (PANs) first developed by Ericsson, later formalized by the Bluetooth Special Interest Group (SIG), which was formally announced May 20, 1999. It was composed by Sony Ericsson, IBM, Intel, Nokia and Toshiba.[23] Bluetooth also uses the 2.4 GHz ISM band. Bluetooth sets up short distance links between enabled devices that can share information over the high bandwidth wireless connection. Such technology is useful for office buildings, government surveys and in educational institutions – where wiring new devices onto the network might be prohibitively expensive.

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[19] This is unlike traditional economic theory, which suggests commons head toward tragedy. *See* Hardin, G., *The Tragedy of the Commons*, Science, 162(1968), p. 1243-1248

[20] Raja, S., *Interference Management In The New Spectrum Organization*, working paper, 2004, p. 5-9, available at http://netfiles.uiuc.edu/sraja/www/tprc04-submit.pdf

[21] Raja, S. and Bar., F, *Transition Paths in a Spectrum Commons Regime*, Telecommunications Policy Research Conference, 2003

[22] http://multiplicity.dk/archives/000503.html

[23] http://en.wikipedia.org/wiki/Bluetooth

Given these examples, and many other possible innovative uses of wireless communications systems, the TRAI must consider the creation of the spectrum commons.

The TRAI Should Allow the Use of all Unlicensed Devices in the Commons

Not only IEEE 802.11a/b/g, all unlicensed approved devices should be allowed for use in all (indoor and out-door) environments. The specification of only one or a few types of systems or uses goes against the Government's aim to develop technology and service-neutral policy. Additionally, it also increases the time lag for legitimate devices to reach the market – this is contradictory to the nation's scientific and technological progress, slowing innovation.

The Indian Wireless Telegraphy Act of 1933 prohibited the possession of wireless telegraphy apparatus without license. The technical rationale behind such regulation traditionally was to prevent interference between different services.[24] A probable political reason for such regulation is that pre-Independence, the British Government of India sought to prevent any radio communication by anyone other than the Government or favored persons. Indeed, there is current scholarship about the impact of the spectrum-licensing regime on the freedom of speech and expression.[25] The Government of India should now reconsider such anti-democratic laws while reframing regulation to respond to improvements in technology and policy systems. The TRAI should begin to consider the benefits of the spectrum commons as outlined above, and ensure that the ISM bands as defined be reserved for use by all types of approved unlicensed devices.

Responses to Specific Questions of the TRAI

Following are responses to specific questions for consultation as listed in the Chapter 7 of the Consultation Paper.

(xvii) Should there be different pricing levels for shared spectrum versus spectrum that is allocated with protection? How should this be determined?

Yes. The TRAI should introduce different pricing levels for shared spectrum versus protected spectrum. Economic theory and historical common precedent will support such differentiated pricing. Protected spectrum is similar to protected property, such as privately held land or a family home. Shared spectrum can be analogized to a shared or

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[24] Raja, S., *Interference Management In The New Spectrum Organization*, working paper, 2004, p. 3-5, available at http://netfiles.uiuc.edu/sraja/www/tprc04-submit.pdf

[25] *See*, for example, New America Foundation, *The Cartoon Guide to Federal Spectrum Policy*, http://www.newamerica.net/Download_Docs/pdfs/Pub_File_1555_1.pdf; Benkler, Y., *Property, Commons, and the First Amendment: Towards a Core Common Infrastructure*, White Paper for the Brennan Center for Justice, March, 2001; Benkler, Y., *Free as the Air to Common Use: First Amendment Constraints on Enclosure of the Public Domain*, 74 N.Y.U. Law Review 354 (1999); Lessig, L. and Benkler, Y., *Net Gains: Is CBS Unconstitutional?* The New Republic, December 14, 1998; Doctorow, C., *Why WiFi is crucial to the First Amendment*, http://boingboing.net/2003/04/17/why_wifi_is_crucial_.html; http://www.hyperorg.com/blogger/mtarchive/001117.html; Frankston, B., *The Legacy of the Spectrum: Communications Policy as Censorship*, http://www.frankston.com/public/Writing.asp?item=Essays/SpectrumLegacy.html

common resource such as a public park. Obviously, the barriers to entry must be greater to a protected property versus a shared resource.

The TRAI must consider allowing use of the shared spectrum gratis in the ISM or other commons bands. The spectrum commons, as has been submitted above, should allow users of approved unlicensed devices to use the resource freely, with least cost in order to promote innovation and high utilization of the resource. In the USA, for example, the ISM bands are used by such devices at no cost to the client. This is the only way to ensure that the benefits of access to spectrum are fully secured.

Protected spectrum should be priced according to market principles and to reflect the true value of the spectrum. The auction or AIP methods are possible ways to price this spectrum.

(xx) Should spectrum be allocated in a service and technology neutral manner?

Spectrum should be allocated in a service and technologically neutral manner. Technological neutrality allows firms or users of spectrum to choose the technology best suited to their specific needs and constraints. Service neutrality allows a user or licensee to provide or use any service in the allocated/assigned spectrum.

Technology neutral spectrum allocation is essential for the spectrum commons. As indicated,[26] the TRAI should migrate away from the indoors-only, IEEE 802.11b only principle and allow the users of approved unlicensed devices to chose the technology that is the most efficient, costs the least, and is the most suited to their needs. If the ISM bands, or any shared spectrum, are not technology neutral, the benefit of innovation is lost. Thus, the TRAI must move towards a technologically neutral spectrum policy, and include the ISM band/spectrum commons in such policy.

Service neutral spectrum policy will allow for the deployment of low cost, advanced communication services over the ISM band spectrum commons. Presently, using WiFi networks, a broadband Internet connection can be provided in rural areas, for example. Such a connection can be used for voice, video, or data. It would go against the TRAI's and Government's aim to increase penetration of such services to rural areas, for example, by not implementing a service neutral spectrum policy.

Thus, to benefit the most from the use of the spectrum commons, the spectrum policy should be technology and service neutral.

(xxii) What procedure for spectrum allocation be adopted for areas where there is no scarcity and in areas where there is scarcity?

Answered along with question (xxiii) below.

(xxiii) Which competitive spectrum allocation procedure (Auction / Beauty Contest) be adopted in cases where there are scarcity?

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[26] TRAI, *Broadband India: Recommendations on Accelerating Growth of Internet and Broadband Penetration*, April 29, 2004, p. 42-44, p. 47

'Areas' can be interpreted in the space and frequency dimension. Since the frequency dimension is more relevant to this submission, the comments are presented as follows.

The areas of spectrum where no scarcity exists should be allocated as a spectrum commons. Indeed, the FCC of the USA commented that, "the commons model should be applied to significant portions of the spectrum, particularly in bands where scarcity is low and transaction costs associated with market mechanisms are high."[27,28]

As explained previously in this submission, the commons does not necessarily become congested or suffer from interference. Indeed, "only in one case – the most severe and unpredictable congestion – is it necessary to transition to another policy regime, where spectrum is allocated in a different manner. This proves that the commons regime would be a good beginning to a new spectrum policy, with a condition that if symptoms of a [Type IV] failure are detected, there might be a transition to a different allocation policy."[29]

To promote innovation in higher frequency bands, and to allow for the development of better and advanced wireless services, the TRAI should allocate spectrum using the commons model where there is no scarcity of spectrum.

In areas, both geographic and spectral, where scarcity is extreme (such as the 800, 900, 1800, 1900 bands) the TRAI should consider using market techniques to allocate spectrum, rather than subjective methods such as beauty contests.[30]

Conclusion

The objective of the TRAI to increase the availability of advanced wireless service to all Indians is supported by the creation of a spectrum commons. The spectrum dedicated to the ISM bands can be easily converted into a spectrum commons, and the approval of unlicensed devices that can use this spectrum can be achieved with available resources.

Allowing the use of approved unlicensed devices in the ISM bands or in any spectrum commons supports the desire of the TRAI and Government to provide the best information and communications services to the Indian public, at the lowest cost, and simultaneously increases the opportunities for national development of advanced wireless devices and services.

This submission humbly requests that the TRAI seriously consider defining the ISM and other non-scarce bands as spectrum commons, and allow the operation of approved unlicensed devices in these bands.

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[27] FCC, Spectrum Policy Task Force Report, 2002, p. 39

[28] *See* Lehr, W., *Economic Case for Dedicated Unlicensed Spectrum Below 3GHz*, 2004, available at http://www.newamerica.net/index.cfm?pg=event&EveID=351

[29] Raja, S. and Bar, F., *Transition Paths in a Spectrum Commons Regime*, p. 22

[30] OECD, *Spectrum Allocation: Auctions And Comparative Selection Procedures - Economic Arguments*, Working Party on Telecommunication and Information Services Policies, available at http://www.oecd.org/LongAbstract/0,2546,en_2649_34225_27125983_119666_1_1_1,00.html

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Appendix A: NFAP 2002 India Footnotes Allocating Spectrum for Unlicensed Uses

IND47 Certain frequency spots in the frequency band 926 – 926.5 MHz may be considered for very low power cordless telephone systems. The use of this band for such purpose is on the basis of non-interference, non-protection and non-exclusiveness.

IND52 Low power devices for cable replacement using spread spectrum technology are likely to be developed in the frequency band 2.4-2.4835 GHz.

IND53 Requirement of Information Technology connectivity will be considered in the frequency band 2.4-2.4835 GHz for Spread Spectrum based non-interference type systems subject to maximum of 4W e.i.r.p. and channel spread of 10 MHz. However, the channel spread up to 20 MHz may be considered on case-by-case basis. The use of this band for this purpose is on the basis of non-interference, non-protection and non-exclusiveness. 2-3 selected bands of 10 MHz each have been earmarked in various areas.

IND57 Frequency band 5725 - 5735 MHz is earmarked for Radio Controlled low power electric gadgets/toys.

IND58 Requirement of low power, spread spectrum based, non-interference type systems may be considered in the frequency band 5725-5825 MHz. Such use will be on the basis of non-interference, non-protection and non-exclusiveness.

Appendix B: FCC Part 15 Technical Requirements for Unlicensed Devices

The following edited information specifies the basic technical requirements for unlicensed devices operating in the 2.4 and 5 GHz bands.[31]

For 2.4 GHz operation

Sec. 15.319 General technical requirements.

(a) The 1910-1920 MHz and 2390-2400 MHz bands are limited to use by asynchronous devices under the requirements of Sec. 15.321. The 1920-1930 MHz sub-band is limited to use by isochronous devices under the requirements of Sec. 15.323.

(b) All transmissions must use only digital modulation techniques.

(c) Peak transmit power shall not exceed 100 microwatts multiplied by the square root of the emission bandwidth in hertz. Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

(d) Power spectral density shall not exceed 3 milliwatts in any 3 kHz bandwidth as measured with a spectrum analyzer having a resolution bandwidth of 3 kHz.

(e) The peak transmit power shall be reduced by the amount in decibels that the maximum directional gain of the antenna exceeds 3 dBi.

(f) The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. The provisions in this section are not intended to preclude transmission of control and signaling information or use of repetitive codes used by certain digital technologies to complete frame or burst intervals.

(g) Notwithstanding other technical requirements specified in this subpart, attenuation of emissions below the general emission limits in Sec. 15.209 is not required.

(h) Where there is a transition between limits, the tighter limit shall apply at the transition point.

(i) Unlicensed PCS devices are subject to the radiofrequency radiation exposure requirements specified in Secs. 1.1307(b), 2.1091 and 2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a ``general population/uncontrolled'' environment. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance

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[31] Information retrieved June 30, 2004 from
http://www.access.gpo.gov/nara/cfr/waisidx_01/47cfr15_01.html

with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

For 5 GHz band:

Sec. 15.407 General technical requirements.

(a) Power limits:

(1) For the band 5.15-5.25 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 50 mW or 4 dBm + 10logB, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 4 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(2) For the band 5.25-5.35 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10logB, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 11 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(3) For the band 5.725-5.825 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 1 W or 17 dBm + 10logB, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 17 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain up to 23 dBi without any corresponding reduction in the transmitter peak output power or peak power spectral density. For fixed, point-to-point U-NII transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in peak transmitter power and peak power spectral density for each 1 dB of antenna gain in excess of 23 dBi would be required. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omni directional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Note to paragraph (a)(3):

The Commission strongly recommends that parties employing U-NII devices to provide critical communications services should determine if there are any nearby Government radar systems that could affect their operation.

(4) The peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement conforming to the definitions in this paragraph for the emission in question.

(5) The peak power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A resolution bandwidth less than the measurement bandwidth can be used, provided that the measured power is integrated to show total power over the measurement bandwidth. If the resolution bandwidth is approximately equal to the measurement bandwidth, and much less than the emission bandwidth of the equipment under test, the measured results shall be corrected to account for any difference between the resolution bandwidth of the test instrument and its actual noise bandwidth.

(6) The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak transmit power (measured as specified in this paragraph) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

(b) Undesirable emission limits: Except as shown in paragraph (b)(6) of this section, the peak emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15-5.25 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.

(2) For transmitters operating in the 5.25-5.35 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz. Devices operating in the 5.25-5.35 GHz band that generate emissions in the 5.15-5.25 GHz band must meet all applicable technical requirements for operation in the 5.15-5.25 GHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of -27 dBm/MHz in the 5.15-5.25 GHz band.

(3) For transmitters operating in the 5.725-5.825 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an EIRP of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of -27 dBm/MHz.

(4) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.

(5) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Sec. 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in Sec. 15.207.

(6) The provisions of Sec. 15.205 apply to intentional radiators operating under this section.

(7) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency block edges as the design of the equipment permits.

(c) The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude the transmission of control or signalling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals. Applicants shall include in their application for equipment authorization a description of how this requirement is met.

(d) Any U-NII device that operates in the 5.15-5.25 GHz band shall use a transmitting antenna that is an integral part of the device.

(e) Within the 5.15-5.25 GHz band, U-NII devices will be restricted to indoor operations to reduce any potential for harmful interference to co-channel MSS operations.

(f) U-NII devices are subject to the radio frequency radiation exposure requirements specified in Sec. 1.1307(b), Sec. 2.1091 and Sec. 2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a ``general population/uncontrolled'' environment. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

(g) Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.