

channel spacing of 20-25 megahertz and suggest that the rules not prohibit U-NII devices from combining channels to enable very wide bandwidth communications.<sup>97</sup> In addition, Nortel states that a 20-25 megahertz minimum channel bandwidth would simplify any industry-developed access protocol by limiting the number of channels that would need to be scanned in order to detect the absence of communications from other devices before transmitting. Further, it notes that such a channeling plan would enable U-NII devices to be compatible with HIPERLAN equipment.<sup>98</sup>

57. On the other hand, several NII proponents argue that, with so many open questions about the future needs for unlicensed wireless networking capabilities, it is premature and technically unwise to specify a channeling plan or a maximum channel bandwidth.<sup>99</sup> The channelization for these bands should be flexible, they state, because the bandwidth required for a given application is dependent on the data rate, communications distance, type of modulation, and specific error correction coding involved. They also claim that a minimum channel width or channelization requirement may limit both technical innovation and flexibility and therefore may increase costs and retard development of new communications options.<sup>100</sup> Finally, although Apple opposes mandatory channelization standards, it states that, in the bands used for high data rate systems, voluntary channelization plans or more informal channelization etiquettes could be developed by industry to promote efficient spectrum use.

58. Most U-NII proponents oppose the imposition of any requirement for modulation efficiency. They claim that such a requirement would increase system complexity and preclude certain modulation techniques, which would in turn increase costs and development time, and delay implementation of U-NII devices.<sup>101</sup> Several commenters oppose the 1 bps/Hz modulation efficiency suggested in the *NPRM* on the grounds that it would preclude spectrum efficient technologies such as spread spectrum, which they observe is spectrally efficient because of its high interference rejection and spectral reuse but may not meet a 1 bps/Hz requirement.<sup>102</sup> Further, several parties claim that efficiency can only be measured meaningfully when geographic frequency re-use (cell area) is also considered, such as bps/Hz/unit-area.<sup>103</sup> These parties argue that a robust system with low modulation

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<sup>97</sup> See WINForum Comments at 25-27, Lucent Comments at 3, and Nortel Comments at 10.

<sup>98</sup> See Nortel Comments at 10.

<sup>99</sup> See, e.g., 3Com Comments at 5 and Business Software Alliance Comments at 2.

<sup>100</sup> See Microsoft Comments at 3-6, Solectek Reply at 21, and 3Com Comments at 5.

<sup>101</sup> See Microsoft Comments at 6, California Wireless, Inc. Comments at 1, and 3Com Comments at 6.

<sup>102</sup> See Motorola Comments at 11 and WINForum Comments at 27.

<sup>103</sup> See Mulcay Reply at 11; Lucent Comments at 4; and Lace, Inc. ("Lace") Reply at i, 5.

efficiency that is capable of operating in the presence of higher potential interference may nevertheless have higher throughput per unit area than a less robust system.<sup>104</sup> Finally, they argue that it is unnecessary to mandate a standard for spectrum efficiency, since the market will decide what efficiency is needed.<sup>105</sup> In this regard, WINForum recommends forgoing the adoption of a modulation efficiency standard at this time in favor of allowing industry groups to consider the development of a more flexible spectral efficiency measure that would take into account frequency reuse characteristics.<sup>106</sup>

59. A few U-NII proponents do support adoption of a modulation efficiency standard. For example, Hewlett-Packard Company ("Hewlett-Packard") recommends a minimum modulation efficiency standard of 0.66 bps/Hz, arguing that, though specification of a high bandwidth efficiency does not guarantee a high spectral efficiency, it can nevertheless prevent low transmission rate systems from using the spectrum inefficiently.<sup>107</sup> Lucent recommends a minimum modulation efficiency standard of 0.5 bps/Hz based on the use of a 3-dB bandwidth, as opposed to use of the full emission bandwidth. If, however, the emission bandwidth were used, Lucent recommends a higher minimum modulation efficiency standard. NTIA also recommends adoption of a bandwidth efficiency standard, but claims that imposition of a strict efficiency limitation at the outset may dampen rapid implementation. Therefore, NTIA recommends that the Commission adopt an effective bandwidth efficiency standard that would come into effect at some reasonable future date, such as three years after conclusion of this rule making proceeding.<sup>108</sup>

60. Finally, some parties, particularly incumbents, argue that a modulation efficiency standard should be required in order to ensure that spectrum is not wasted. They state that highly efficient technologies currently exist and that it is not unreasonable to require U-NII devices to have modulation efficiencies higher than 1 bps/Hz. Alstatt Associates, for example, argues that, since digital television set-top boxes have a modulation efficiency of 6.66 bps/Hz, and Part 21 and 94 devices have a minimum modulation efficiency of 4.46 bps/Hz, U-NII devices should be required to have a minimum efficiency of 3 bps/Hz.<sup>109</sup> Larus Corporation ("Larus") agrees that we should adopt a modulation efficiency standard of no less than 3 bps/Hz,<sup>110</sup> while the Northern Amateur Relay Council of California, Inc.

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<sup>104</sup> See, e.g., Lucent Comments at 4.

<sup>105</sup> See, e.g., California Wireless Comments at 1.

<sup>106</sup> See WINForum Reply at 20.

<sup>107</sup> See Hewlett-Packard Comments at 7.

<sup>108</sup> See NTIA Reply at 12.

<sup>109</sup> See Alstatt Comments at 2.

<sup>110</sup> See Larus Comments at 2.

("NARCC") argues that a spectrum efficiency of 2 bps/Hz is appropriate and has in fact been achieved for years.<sup>111</sup>

61. *Decision.* One of our goals in this proceeding is to provide rules which permit maximum technical flexibility in the design and development of U-NII devices capable of providing high data rate communications for a variety of multimedia applications in a shared spectrum environment. Such devices have not yet been designed, built, or tested. Accordingly, we believe that adopting a rigid channelization plan or mandating a modulation efficiency standard at this time would not meet this goal, and could delay implementation of U-NII devices by precluding certain technologies or applications. Further, we believe that the low power limits we are adopting will ensure efficient use of the spectrum by providing for high frequency reuse, which will allow for large numbers of U-NII devices to share the spectrum in any geographic area. We also believe that establishing a channelization plan or modulation efficiency at this early stage in the technological development of the devices might have several undesirable effects, such as increasing costs and delaying the benefits of U-NII devices to the public. Accordingly, we will not adopt a channeling plan or a modulation efficiency standard at this time.

62. Nevertheless, we note that the focus of this proceeding is to make available spectrum for broadband high data rate unlicensed devices capable of meeting the communications requirements of new multimedia applications. We therefore agree with those commenting parties that suggest the purpose of making these bands available is to support use of high data rate devices. Accordingly, we are adopting a definition for the type of devices that will be approved for this band. Specifically, the Part 15 rules will state that unlicensed U-NII operations in the 5.15-5.35 GHz and 5.725-5.825 GHz bands will be limited to wide bandwidth, high data rate digital operations. Unlicensed devices accessing the 5.725-5.825 GHz band under other Part 15 rules would not be subject to this definition. This will give equipment manufacturers the flexibility to design and manufacture a variety of broadband devices using different technologies and modulation techniques, while ensuring that this spectrum is used for its intended purpose. This definition will be enforced through the Commission's equipment certification process.

#### D. *Spectrum Etiquette*

63. In the *NPRM*, we proposed a basic "listen-before-talk" ("LBT") spectrum sharing etiquette, similar to that established for U-PCS devices,<sup>112</sup> to ensure that the U-NII spectrum is used by devices in a manner that would permit them to share with one another.<sup>113</sup> We suggested that the proposed etiquette could serve as an interim protocol standard until

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<sup>111</sup> See NARCC Comments at 6.

<sup>112</sup> See 47 CFR § 15.321.

<sup>113</sup> See *supra*, *NPRM* at para. 52.

industry developed a spectrum sharing etiquette. In this regard, the *NPRM* encouraged industry to develop appropriate etiquette protocols for these devices through a consensus process and stated that, if appropriate, we would consider those protocols in this or a further rule making proceeding. Finally, we solicited comments on whether such an etiquette should be required at all, or whether the minimal technical requirements would be sufficient to ensure spectrum sharing among U-NII devices.

64. *Comments.* The commenters overwhelmingly oppose the LBT spectrum etiquette proposed in the *NPRM* for U-NII devices. Several parties argue that the LBT protocol is unnecessary and would be detrimental to U-NII devices at 5 GHz. For example, Motorola states that LBT would be ineffective in controlling interference among U-NII devices, particularly in buildings with many rooms and hallways. Several commenters also assert that LBT would be detrimental because it would preclude isochronous multimedia applications and other technologies such as Asynchronous Transfer Mode ("ATM") that would not be able to comply with strict transmission time-frame requirements.<sup>114</sup> Motorola claims that LBT would unduly restrict the utilitarian choices which manufacturers of U-NII devices could offer to consumers.<sup>115</sup>

65. Additionally, some commenters oppose establishing any interim etiquette on the grounds that devices developed under such an interim etiquette could be rendered useless once a permanent etiquette is adopted.<sup>116</sup> In this regard, Lucent asserts that adoption of an interim etiquette would hinder introduction of future systems and would inhibit the process of developing an industry consensus for spectrum sharing rules. Cylink contends that interim rules would harm the competitiveness of small businesses. It claims that only larger companies could afford to cover the risk of betting on the eventual outcome of industry working group deliberations aimed at adopting a consensual etiquette. Similarly, WINForum expresses concerns about the compatibility of interim devices with any subsequent permanent spectrum etiquette and suggests that any interim operations should be constrained to 50 megahertz in the upper band with a date-certain changeover mandate.

66. Several commenters, while not supporting the proposed LBT etiquette, do support the development of a spectrum etiquette, or of multiple etiquettes, by industry consensus in order to help minimize interference among U-NII devices.<sup>117</sup> For example, WINForum states that high-level protocols, like that adopted for U-PCS, may be excessively complex for U-NII devices, but simple RF rules (*e.g.*, power limits, channelization, unwanted

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<sup>114</sup> See, *e.g.*, Lucent Comments at 5, Nokia Mobile Phones Americas, Inc. Comments at 2, and WINForum Comments at 20.

<sup>115</sup> See Motorola Comments at 2.

<sup>116</sup> See Lucent Comments at 5, Cylink Reply at 17, WINForum Comment at 20, and Mulcay Reply at 6.

<sup>117</sup> See Rockwell Comments at 3, WINForum Reply at 21, and CEMA Reply at 6.

emission limits) may prove insufficient to ensure fair, efficient, and open access.<sup>118</sup> It adds that the development of such standards is appropriately left to voluntary standards organizations. NTIA also supports some type of channel monitoring protocol or U-NII etiquette to minimize interference, both to and from radar systems.<sup>119</sup> Further, several other commenters aver that industry should be permitted to develop etiquettes within a time frame mandated by the Commission.<sup>120</sup>

67. Some commenters oppose the adoption of any spectrum etiquette, stating that a required etiquette would inevitably limit innovation in the development of new U-NII products, and that the use of etiquettes has not always been proven to avoid interference. The Connectivity for Learning Coalition ("Coalition") asserts that while such protocols mandate a manner in which some technologies may share the spectrum, use of those technologies may or may not meet the needs of the education or library communities.<sup>121</sup> Metricom, Inc. ("Metricom") states that, in theory, an etiquette may appear to allow for spectrum sharing, but there is no practical evidence that complex etiquettes prevent interference.<sup>122</sup> Metricom states that creative engineers guided by minimal technical standards will best be able to design communications solutions to match consumer needs. Finally, 3Com Corporation ("3Com") claims that a formal spectrum etiquette would limit ingenuity and development of U-NII devices, and it urges the Commission to encourage the development of voluntary spectrum etiquettes to permit interoperability.<sup>123</sup>

68. *Decision.* In general, we believe that a spectrum etiquette can provide benefits by facilitating compatibility among devices and allowing for equal access to the spectrum by devices that use different technologies. However, we do not believe that the interim LBT etiquette proposed in the *NPRM* would provide such benefits for unlicensed U-NII devices in the 5 GHz band. As pointed out in the comments, that LBT etiquette would be ineffective in controlling interference among devices and would preclude some technologies that may be desirable for U-NII devices. Accordingly we will not adopt our proposed etiquette.

69. We also note that the record does not provide an alternative spectrum etiquette to our proposed LBT etiquette that we could adopt at this time. Additionally, we do not think

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<sup>118</sup> See WINForum Reply at 21.

<sup>119</sup> See NTIA Reply at 11.

<sup>120</sup> See Apple Reply at 29 and CEMA Reply at 6, 7.

<sup>121</sup> See Coalition Reply at 4.

<sup>122</sup> See Metricom Comments at 14.

<sup>123</sup> See 3Com Comments at 7.

that it would be in the public interest to wait for an industry group to develop a satisfactory new etiquette as suggested by WINForum. We are concerned that it could take industry a substantial period of time to develop an etiquette for unlicensed U-NII devices at 5 GHz, because of the wide range of interests that would have to be accommodated in establishing a single etiquette for all the broad multimedia applications envisioned for U-NII devices. Further, after such an etiquette is developed, we would have to conduct a rule making proceeding to adopt the etiquette as a mandatory standard. Completing these activities would take at least a year, and possibly considerably longer. We do not believe that such a delay in implementing rules permitting U-NII operations would serve the public interest.

70. We recognize that there are trade-offs in adopting any etiquette and that the benefits of an etiquette must be weighed against its drawbacks. For example, an etiquette could beneficially facilitate compatibility among devices and thus promote spectrum sharing, inter-communications among different devices, and equal access to the spectrum by devices built by various manufacturers. Drawbacks of an etiquette include an increase in the complexity of equipment design and, hence, an increase in cost to the manufacturer and the user, as well as a potential limitation on access to the spectrum by some technologies and equipment. In the instant case, it is early in the developmental stage for equipment to operate in these shared bands as intended. Therefore it may be very difficult to develop a spectrum etiquette at this time that will not limit the types of equipment that could most efficiently or effectively provide the desired broadband communications.

71. Accordingly, we are not adopting a spectrum sharing etiquette at this time, nor will we delay access to the 5 GHz bands by U-NII devices until industry develops an etiquette. We believe the minimal technical rules we are adopting, particularly the maximum power limits discussed above, will generally allow for equal access and sharing of these bands by U-NII devices and thereby accomplish the intent of our proposed spectrum etiquette. Finally, our course of action will not preclude industry from developing any voluntary standards that it deems appropriate in the future. In this regard, we continue to encourage industry to develop appropriate etiquette protocols through a cooperative consensus process. If standards are developed that would better facilitate sharing of this band without precluding U-NII devices or technologies, we would consider adopting those protocols in a further rule making proceeding. We note that WINForum states that it has already begun setting the foundation for joint industry action in this area. We encourage all interested parties to take part in this process and to cooperate in good faith.

#### E. *Spectrum Sharing Considerations*

72. In the *NPRM*, we recognized that a number of primary services now use, or soon will use, the spectrum which we proposed for U-NII devices. The existing operations include Government radiolocation systems; mobile satellite feeder links; amateur operations; industrial, scientific, and medical operations; other unlicensed Part 15 operations; and proposed ITS. We stated in the *NPRM* that it would be necessary to develop spectrum

sharing criteria between primary operations and the new U-NII devices. We tentatively concluded in the *NPRM* that sharing would be feasible, but requested comments on this issue.

73. *Comments.* NTIA, the Government agency responsible for the spectrum management for Government operations, supports our proposal to permit U-NII devices to share these bands with primary Government operations.<sup>124</sup> However, NTIA urges us to adopt sharing protocols and power limitations to facilitate sharing. NTIA states that the success of community networks will depend on their geographic separation from high powered radar systems operating in these bands. NTIA adds that Federal radar systems serve the interests of national security and that, therefore, all efforts should be made to avoid operating community network links near military radar sites. Additionally, NTIA states that compatibility analyses of long range links with existing radar needs to be completed for both U-NII and spread spectrum systems before higher powers are authorized.

74. In the 5.15-5.25 GHz band, parties with MSS interests argue that sharing is not feasible between MSS feeder links and new U-NII devices. In particular, L/Q asserts that only 1070 simultaneous users of U-NII devices could operate in the 5.15-5.25 GHz segment in the continental United States before unacceptable interference would be caused to the feeder links for Globalstar, its proposed mobile satellite system.<sup>125</sup> Airtouch Communications, Inc. ("Airtouch"), a limited partner in Globalstar, claims that its analysis indicates that U-NII operations in the 5.15-5.25 GHz band would reduce the capacity of Globalstar in the U.S. by over 27%.<sup>126</sup> Further, Airtouch and L/Q argue that the European sharing analysis for HIPERLAN, addressed in the *NPRM*, cannot be applied in this proceeding because U-NII devices and HIPERLAN do not have similar technical parameters and the International Telecommunication Union ("ITU") analysis is not based on current data.

75. On the other hand, U-NII proponents claim that U-NII devices would be able to share with Government radiolocation and MSS feeder uplinks operations because of the very low power with which U-NII devices will operate in the 5.15-5.25 GHz band and because of the attenuation characteristics of radio signals in the 5 GHz range. With regard to sharing with MSS feeder uplink operations, they conclude that MSS feeder operations would also be able to share with U-NII devices. They base this conclusion on the ITU study, which predicted that HIPERLAN systems would be able to co-exist with the MSS feeder links in the 5.15-5.25 GHz band in Europe. Further, they note that HIPERLAN devices will be operating at 1 W, a power level substantially higher than the power limit proposed for U-NII devices in

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<sup>124</sup> NTIA also states that U-NII devices should not be permitted to operate below 5.15 GHz, where Microwave Landing Systems ("MLS") operate. Also, NTIA requests that future ITS operations in the 5.85-5.875 GHz band be protected by limiting U-NII devices in this band to the proposed 100 mW EIRP. We are not making either of these spectrum bands available for use by U-NII devices.

<sup>125</sup> See L/Q Comments at 8.

<sup>126</sup> See Airtouch Reply at 7.

this band, and that global MSS systems must be built to be robust enough to share with HIPERLAN. WINForum and Solectek Corporation ("Solectek") also counter L/Q's claim that only 1070 U-NII devices could use the band in the United States before causing interference to MSS feeder links, pointing out that L/Q made strict assumptions that are not representative of the U-NII device environment.<sup>127</sup> Specifically, WINForum notes that ITU's studies assume a more reasonable performance margin of 0.41 dB rather than the 0.004 dB that L/Q used. Based upon these more realistic criteria, WINForum claims that over 540 million U-NII devices could be deployed in the United States without causing harmful interference to the FSS uplink systems.

76. Additionally, some parties argue that use of directional antennas will decrease the radiation perceived by a satellite above the users in the vertical plane. Further, Lace, Inc. ("Lace") argues that a 10% power increase in the MSS feeder link would easily resolve the interference problem, if indeed that problem ever occurs.<sup>128</sup> Lace and Solectek argue that there are other means to mitigate interference such as power spectral density limits, transmitter on-time limits, station antenna directivity, relay link antenna directivity, out-of-band noise rejection, and positioning long range outdoor links above 5.25 GHz.

77. In the 5.725-5.825 GHz band, incumbent operators either oppose allowing U-NII operation due to interference concerns or urge that sharing studies be completed before that band is made available to U-NII devices. For example, the San Bernardino Microwave Society ("SBMS") argues that sharing between U-NII devices and amateur operations is not possible.<sup>129</sup> However, the ARRL states that the proposed U-NII maximum power limit of 100 mW EIRP appears to be sufficient to avoid significant interference to the amateur service, but it argues that the ubiquitous nature, mobility, and potential aggregate interference potential of these devices necessitates that sharing studies be performed.<sup>130</sup> Additionally, Section 15.247 spread spectrum interests oppose U-NII operations in this band and argue that without a means to control usage, operations in this band would rapidly degrade and become unusable.<sup>131</sup> Further, incumbents oppose high power U-NII operations in this band because they argue it is more likely to cause interference to incumbent operations.<sup>132</sup> The ARRL also claims that higher power U-NII operations should not be permitted because the Commission is unlikely to enforce the requirement that unlicensed device users cease operation if they are

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<sup>127</sup> See Solectek Reply at 20 and WINForum Reply at 8-10.

<sup>128</sup> See Lace Reply at 2.

<sup>129</sup> See SBMS Reply at 1.

<sup>130</sup> See ARRL Comments at 9-11.

<sup>131</sup> See US West Reply at 3 and Larus Comments at 2.

<sup>132</sup> See ARRL Reply at 8 and WFTEP Reply at 1.

causing harmful interference to allocated services. Finally, Metricom states that to avoid interference, U-NII devices in the upper band should be required to operate in spread spectrum mode.<sup>133</sup>

78. On the other hand, U-NII proponents argue that U-NII devices can share with Government radiolocation, amateur operations, ISM devices, other Part 15 devices and proposed ITS operations. They argue that these incumbent operations already share this band with other types of unlicensed devices. In this regard, Mulcay notes that a substantial number of devices, including Part 15 direct sequence spread spectrum radios with 1 W output power and antenna gains of 30 dBi, frequency hopping radios with omni-directional antennas and non-communication devices under Part 18 with no limit on radiated power, already share the 2.4 and 5.8 GHz bands on an unlicensed, non-coordinated basis without causing interference.<sup>134</sup> WINForum likewise argues that U-NII devices operating under equivalent technical standards can also share this band without causing harmful interference.<sup>135</sup> Apple notes that U-NII devices will only share a part of the 275 megahertz wide amateur band at 5.65-5.925 GHz and, therefore, claim that U-NII operations will not significantly affect the amateur radio service.<sup>136</sup> With regard to sharing with other Part 15 devices, U-NII proponents contend that the record demonstrates that U-NII devices can be designed to coexist with spread spectrum devices. CEMA argues that industry can develop technical guidelines and methodologies to allow community network systems and other systems to share unlicensed bands.<sup>137</sup> Further, Apple claims that directional antennas will reduce the probability that multiple devices will compete for spectrum in overlapping areas.

79. *Decision.* We continue to believe that U-NII devices can share these bands with existing and future operations. Specifically, we believe that the power limits, power spectral density requirements and emission limits that we are adopting herein will permit the robust development of U-NII devices without a significant impact on other spectrum users. With regard to Government operations, we agree with NTIA that MLS operations below 5.15 GHz must be protected. Accordingly, we are not allowing U-NII devices access to spectrum below 5.15 GHz. We believe that this decision, along with the power limits and out-of-band emission limits, will adequately protect MLS operations. We also agree with NTIA that co-channel sharing with Government radiolocation is possible. We believe the power limits we are adopting will allow for this sharing as detailed below. Further, we believe that there

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<sup>133</sup> See Metricom Reply at 12.

<sup>134</sup> See Mulcay Reply at 8.

<sup>135</sup> See Winforum Reply at 11.

<sup>136</sup> See Apple Comments at 16.

<sup>137</sup> See CEMA Reply at 4,5.

will be no interference from U-NII devices to possible ITS operations, since we are not allowing U-NII devices access to the 5.85-5.875 GHz band.

80. In the 5.15-5.25 GHz band, we note that the sharing analyses completed to date often reach different results because they are based on different assumptions. For example, since the CEPT studies were made, Globalstar has changed some of the parameters of its system, and, therefore, MSS feeder links potentially could be more susceptible to interference than those studies concluded. Based upon the information before us, we conclude that the limits we are adopting will ensure that U-NII devices do not cause harmful interference to MSS feeder link operations.

81. In the 5.25-5.35 GHz band, we believe that the 1 W EIRP limit and the power spectral density requirements we are adopting for U-NII devices will adequately protect the primary radiolocation operations. We note that Government radiolocation systems are limited in number and generally located at remote military sites, on board ships, in aircraft and in spacecraft, and that these considerations in conjunction with the U-NII power limits should adequately protect the radiolocation service. Further, U-NII devices will have to accept interference from the radiolocation service.

82. In the 5.725-5.825 GHz band, we believe that the 4 W EIRP limit and the power spectral density requirements we are adopting for U-NII devices will adequately protect the primary radiolocation operations and amateur operations. These limits provide U-NII devices with power levels equivalent to Part 15 spread spectrum devices that already share this band with incumbent services. Therefore, U-NII devices should likewise be able to share this band without causing interference to the primary services. Further, with regard to spectrum sharing with the amateur service, we note that the amateur service has access to 275 megahertz of spectrum in the 5.65-5.925 GHz band. We believe amateur licensees will, if necessary, be able to operate around U-NII devices, which only have access to 100 megahertz in this portion of the 5 GHz spectrum. Additionally, we note that we are not at this time providing spectrum above 5.825 GHz for U-NII devices. This eliminates any sharing concerns with users or potential users of the 5.825-5.875 GHz band, which includes lower power Part 15 devices such as hearing aid devices, as well as ITS operations, and FSS operations.

83. We also believe our power spectral density requirements will permit U-NII devices to share this spectrum with unlicensed spread spectrum devices as the potential for interference to these devices from new U-NII devices will be no greater than that which would be expected from additional spread spectrum devices. Thus we see no reason to restrict U-NII devices in this band to spread spectrum technologies as requested by some commenters. Accordingly, we will allow U-NII devices in this band to operate on a

technology-neutral basis. We believe this will provide manufacturers flexibility in designing U-NII products and thus will provide consumers with greater choices.<sup>138</sup>

F. *Alternative Regulatory Structure*

84. In the *NPRM*, we proposed to allow U-NII devices to operate on an unlicensed basis. We tentatively concluded that the low power and limited range of U-NII devices would make licensing administratively difficult for users and the Commission. Further, we noted that this spectrum may be of very limited use to licensed services due to the presence of incumbent operations. Nonetheless, we requested comment on whether new U-NII operations should be provided on a licensed basis. We also solicited comments with regard to whether we should license higher power community networks if we were to allow such operations. We also asked whether, in the case of mutually-exclusive applications, we should use competitive bidding to award such licenses.<sup>139</sup>

85. *Comments.* Most U-NII proponents support our proposal to allow U-NII devices to operate on an unlicensed basis. They oppose licensing and auctions of any U-NII operations, arguing that the benefits of authorizing Part 15 devices and systems would be undermined completely if licensing were required.<sup>140</sup> They state that licensing -- even expedited licensing -- would impede deployment, reduce innovation, reduce spectrum efficiency, increase costs, undermine the development of community networking and deny the benefits of low cost and flexible alternatives to existing media.<sup>141</sup> Apple also contends that unlicensed community networks would not create problems of regulatory parity for common carriers and other profit making service providers. It states that those electing to use unlicensed bands would accept the fact that they will not control their spectrum environment and will be limited to low power operations; in exchange, they would be freed from the costs and burdens associated with licensing.<sup>142</sup>

86. However, AT&T, PacTel, TIA and some microwave equipment manufacturers state that if the Commission permits the operation of longer range community networks, those networks should be subject to licensing and auctions. AT&T states that allowing unlicensed community networks would be unfair to the holders of existing spectrum licenses, particularly

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<sup>138</sup> Allowing U-NII devices in this band to operate on a technology-neutral basis will give manufacturers choices in that U-NII spread spectrum devices will be more robust and will provide longer communication distances but will not be able to provide the higher data rates of U-NII devices operating with the same power but with a more conventional digital modulation technology.

<sup>139</sup> See 47 U.S.C. § 309(j)(2)(A).

<sup>140</sup> See Apple Comments at 20, CEMA Comments at 5, and WINForum Reply at 25.

<sup>141</sup> See ITIC Comments at 5 and Cylink Comments at 10.

<sup>142</sup> See Apple Reply at 17.

those who received their licenses through the auction process, and would undermine the Congressional objective of promoting regulatory parity among wireless services.<sup>143</sup> AT&T further states that the type of operation envisioned for community networks requires a degree of reliability and quality that can only be realized through licensed services. PacTel argues that unlicensed community networks would create an inequitable regulatory structure where unlicensed service providers operate in competition with licensed service providers without the common carrier obligations of a licensee.<sup>144</sup> TIA states that implementing long range networks requires frequency coordination, use of narrow beam antennas and other fundamental components of licensing in order to succeed.<sup>145</sup>

87. *Decision.* We continue to believe that low power U-NII devices and associated operations are more amenable to an unlicensed structure and should be regulated under the Part 15 rules. Specifically, the rules governing U-NII devices are similar in their low power and flexible regulatory nature to those governing Part 15 devices. While some U-NII devices in the upper band could have ranges of several kilometers, we believe that most devices will have typical communication ranges of a few meters to a few hundred meters. Additionally, like other existing unlicensed devices, we believe that trying to license U-NII devices individually would be administratively difficult if not impossible for both the Commission and the consumer and would greatly delay the implementation and use of this band by U-NII devices. Further, we do not think it would be advisable at this time to license spectrum blocks and large service areas to providers.

88. We also are unpersuaded by the arguments that U-NII devices and associated operations need to be licensed in order to provide regulatory parity with licensed services. With regard to unlicensed U-NII devices that are used for community networks in the upper band, we note that these will also be of very limited range in comparison to the distances of fixed point-to-point operations, will have to operate in a Part 15 sufferance mode and may not always be able to provide the same grade of service as the licensed operations. That is, they will receive no protection from other users of the spectrum. Further, we note that in the upper band unlicensed devices are already providing point-to-point links for data transmissions, typically of up to 1.5 Mbits/sec. Further, we believe that the vast majority of U-NII devices will provide communications that are complementary to, rather than competitive with, the licensed services. We believe that the relationship between U-NII devices and the licensed point-to-point services will be analogous to the relationship between cordless telephones and PCS or the cellular telephone service. That is, U-NII devices will provide a variety of broadband high data rate services but only in a very limited range and generally on the premises of the users, while licensed fixed point-to-point microwave services

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<sup>143</sup> See AT&T Comments at 4.

<sup>144</sup> See PacTel Comments at 5.

<sup>145</sup> See TIA Reply at 8.

provide communication links that are substantially longer, up to 30 and 40 miles, and in a controlled radio environment where the licensee has the right of protection from interference.

89. We do believe, however, that this proceeding has raised a number of spectrum issues that warrant further attention. Users and manufacturers of unlicensed devices, for example, may have little incentive to make the investment necessary to improve spectrum efficiency and thus allow more users to benefit. As we continue to implement spectrum policies that promote competition and efficiency we may also need to consider how to harmonize these policies with those for unlicensed devices.

G. *New Part 16 Regulations*

90. In the *NPRM*, we tentatively concluded that the technical and operational flexibility afforded under Part 15 is the appropriate structure for regulating U-NII devices, rather than a new Part 16 regulatory scheme. Under the Part 16 concept, unlicensed devices could be treated as a recognized radio service with spectrum rights, including interference protection. Alternatively, we proposed to establish a "safe harbor" or clear technical operating parameters under which users of unlicensed U-NII devices could operate without being considered sources of harmful interference.<sup>146</sup> Consistent with Part 15 operations, we also proposed that U-NII devices have to accept any interference.

91. *Comments.* NII proponents support the principles underlying either "safe harbor" or the Part 16 approach. Apple argues that for U-NII devices to become viable, these devices must be treated as a recognized radio service, and their operations must be in protected spectrum reflected in Section 2.106 of the rules, the Table of Frequency Allocations.<sup>147</sup> Further, Apple states that the Commission should make clear that it will not introduce new, incompatible services into the NII bands in the future. Apple argues this is fully consistent with both the Communications Act and Commission precedent; in that, it is identical to the approach adopted for unlicensed-PCS and millimeter wave bands. Further, Apple argues that this approach is consistent with the Commission's obligation under Section 303(g) of the Communications Act to 'study new uses for radio... and generally encourage the larger and more effective use of radio in the public interest.' CEMA also argues that the Commission has the authority to elevate the status of unlicensed devices and suggests upgrading the status of U-NII devices to co-primary within the allocated bands. It claims that otherwise these devices will remain, by regulatory design, second class citizens in the RF environment.<sup>148</sup> Further, WINForum claims that some rural and educational users may not be willing to risk investment in equipment absent some reassurance that their communication

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<sup>146</sup> See *supra* *NPRM*, at Para. 54, 60.

<sup>147</sup> See Apple Comments at 27-28.

<sup>148</sup> See CEMA Comments at 7.

needs will be met now and in the future.<sup>149</sup> Finally, Cylink, Metricom and existing unlicensed spread spectrum device providers argue that if additional protection is provided to unlicensed U-NII devices in this range of the spectrum, then this protection also should be extend to unlicensed spread spectrum devices.

92. However, Airtouch and other parties with interests in the 5.15-5.35 GHz and 5.725-5.825 GHz bands state that the "safe harbor" concept conflicts with the Part 15 regulatory scheme and would relieve unlicensed users of their obligation to avoid interference to licensed users.<sup>150</sup> L/Q argues that an analogy cannot be made to the protection provided to unlicensed Data-PCS devices because unlicensed Data-PCS devices received an allocation of exclusive spectrum, but U-NII devices will not operate on exclusive spectrum. SBMS and other amateur interests oppose "safe harbor" rules because there will be no means of enforcement to prevent U-NII devices from causing interference.

93. *Decision.* We generally have provided spectrum for low power unlicensed devices on a non-interference basis, meaning that unlicensed devices must not cause interference to licensed users and must accept any interference they receive. This regulatory approach to accommodating unlicensed devices has protected licensed use while permitting the development of a wide variety of low power unlicensed devices. While we seek to encourage the important and valuable telecommunication operations which will be provided by U-NII devices, we find that the current record does not provide a compelling reason to believe that such devices require higher or more protected status than we have provided for low power unlicensed devices in the past. Accordingly, we do not believe that it is necessary to create a new Part 16 or "safe harbor" rules to provide additional protection for U-NII devices. We therefore, as discussed below, will regulate these devices in the same manner that we regulate other low-power unlicensed devices. We do conclude, however, that some special consideration is warranted with regard to the use of unlicensed devices in the lower band, 5.15-5.25 GHz, which will be shared with MSS.

94. In the 5.25-5.35 GHz and 5.725-5.825 GHz bands, where the radio environment is well established with mature services, we can adopt rules in Part 15 for U-NII devices in which all parties can have confidence that sharing is possible with little or no threat of interference. In both of these bands, we believe U-NII device manufacturers and users can feel confident that their operations will not cause interference to primary operations, because in the 5.25-5.35 GHz band the only party authorized to use this spectrum is Government radar operations, with which we believe low power U-NII devices can share spectrum without causing interference, and because the U-NII devices in the 5.725-5.825 GHz band will operate with powers equivalent to those of existing unlicensed operations that currently share this band without causing interference. Additionally, if interference problems did occur in these

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<sup>149</sup> See WINForum Reply at 23.

<sup>150</sup> See Airtouch Reply at 3; L/Q Reply at 13, 16, 17; and SBMS Reply at 3.

bands they would be localized and could probably be identified and resolved. In these cases we believe that the current Part 15 at sufferance rules are appropriate.

95. We recognize that it is likely that two new uses of the 5.15-5.25 GHz band, MSS feeder link operations and U-NII devices, will be developing at the same time. In view of this fact, as indicated above, we are adopting relatively conservative operating parameters for U-NII devices. We believe that the very low power limits and indoor use restriction on unlicensed operations will ensure that millions, or even tens of millions, of U-NII devices can successfully co-exist and share the spectrum with MSS feeder links. Further, we note that interference from U-NII devices to MSS operations could potentially occur only as a result of the cumulative effect of many millions of U-NII devices and not by any single device. To the receiver on the MSS satellite, the operation of many low power U-NII devices looks like an increase in the ambient noise floor. This has the effect of decreasing the desired signal-to-noise ratio received from the higher power MSS feeder link and can ultimately reduce the capacity of or cause interference to MSS operations.

96. While we believe that this approach for U-NII devices is technically conservative and will fully protect MSS operations, we note that MSS interests have also suggested that we limit the aggregate EIRP density of emissions from unlicensed devices on the Earth's surface to the MSS satellite to 10 dBW/MHz.<sup>151</sup> They argue that MSS operations could begin to be affected when emissions from unlicensed devices approach such a level.<sup>152</sup> Alternatively, they suggest that the Commission should review the technical parameters for U-NII operations in a future rule making as such a limit is approached. They state this would allow the Commission to review, for example, whether some future reduction in permitted power of U-NII devices in this band should be imposed. They state that all existing U-NII devices would be grandfathered. We concur that such an approach would provide further assurance that future potential conflicts between U-NII devices and MSS operations are taken into account and that MSS operations are protected appropriately. Accordingly, we invite MSS parties to monitor the emissions from U-NII devices in the 5.15-5.25 GHz band and, if emissions approach the 10 dBW/MHz level, to request that we initiate a rule making to reassess the use of this band.<sup>153</sup> At that time the Commission could determine if future U-NII

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<sup>151</sup> This equates to a power flux density of -124 dBW/MHz/m<sup>2</sup> at a satellite with a slant range of 1414 km. See *ex parte* filing of Airtouch, December 5, 1996; see also, *Draft New Recommendation - Power Flux Density Limits for Wireless Data Networks In The 5150-5250 MHz Band Sharing Frequencies With Systems In The Fixed Satellite Service*, to ITU-R Working Party 4-9S, David E. Weinreich of Globalstar, November 27, 1996.

<sup>152</sup> Given the indoor restriction and power limits we are imposing on U-NII devices and taking into account other factors such as duty cycle, it would take millions, or even tens of millions of devices, to achieve this level of 10 dBW/MHz.

<sup>153</sup> We also note that it may also be appropriate to reassess the technical parameters governing U-NII devices in light of second generation MSS systems. For example, second generation MSS systems may be more sensitive and therefore more susceptible to interference from U-NII devices. On the other hand, if European HIPERLAN systems proliferate and operate at more power than U-NII devices, second generation MSS systems may be required

devices should be required to operate at different technical standards. In this regard, we note that it may also be appropriate to reassess the technical parameters governing U-NII devices in light of second generation MSS systems. For example, second generation MSS systems may be more sensitive and therefore more susceptible to interference from U-NII devices. On the other hand, if European HIPERLAN systems proliferate and operate at more power than U-NII devices, second generation MSS systems may of necessity be designed to be more robust and immune to interference from such devices.

97. We believe that this approach will provide both MSS feeder link and U-NII operations with an appropriate level of protection and assurance for the continuation of their operations. While we think it unlikely that an interference situation will arise, this approach will permit us to develop regulatory solutions that will adequately protect the investments of both services, if such a situation were to develop. Accordingly, we believe that this approach will provide both the MSS community and the U-NII device manufacturers with adequate certainty concerning their operations, and we do not believe that a "Part 16" or "safe harbor" rule is necessary for U-NII devices at this time.

#### H. *Equipment Authorization*

98. In the *NPRM*, we proposed that U-NII devices would be subject to our certification requirements pursuant to Section 15.201(b), prior to marketing. Motorola recommends that we take this opportunity to streamline our equipment approval process so that all products, including U-NII devices, may be approved and provided to the public with minimal costs and delays.<sup>154</sup> However, Motorola made no specific suggestion in reference to this proceeding and its comments in reference to PP Docket No. 96-17 will be considered therein. We do not believe that applying the certification process to U-NII devices will significantly delay the provision of this equipment to the public. We believe this process helps prevent non-compliant devices from interfering with other devices or services. Accordingly, we are adopting our proposal to require U-NII devices to comply with the existing certification requirements for intentional radiators under Part 15.

99. Finally, we will require U-NII devices to comply with the RF hazard requirements set forth in Sections 1.1307(b), 1.1310, 2.1091, and 2.1093 of our rules.<sup>155</sup> For purposes of these rules, all U-NII equipment will be deemed to operate in an "uncontrolled" environment. Any application for equipment certification for these devices must contain a statement confirming compliance with these requirements. Technical information showing the basis for this statement must be submitted to the Commission upon request.

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to more robust and immune to interference from such devices.

<sup>154</sup> See Motorola Comments at 12.

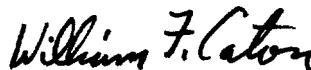
<sup>155</sup> See 47 CFR §§ 1.1307(b), 1.1310, 2.1091, and 2.1093.

**ORDERING CLAUSE AND EFFECTIVE DATE**

100. Accordingly, IT IS ORDERED that Part 15 of the Commission's Rules, 47 C.F.R. Part 15 IS AMENDED as set forth in the attached Appendix, effective 60 days after publication in the Federal Register. This action is taken pursuant to Sections 4(i), 303(c), 303(f), 303(g) and 303 (r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 303(c), 303(f), 303(g) and 303(r).

101. *Regulatory Flexibility Analysis.* As required by Section 603 of the Regulatory Flexibility Act ("RFA"),<sup>156</sup> an Initial Regulatory Flexibility Analysis ("IRFA") was incorporated in the *NPRM* in this proceeding. The Commission sought written public comments on the proposals in the *NPRM* including on the IRFA. The Commission's Final Regulatory Flexibility Analysis ("FRFA") in this Report and Order is attached as Appendix B.

FEDERAL COMMUNICATIONS COMMISSION

  
William F. Caton  
Acting Secretary

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<sup>156</sup> See 5 U.S.C. § 603.

**APPENDIX A: FINAL RULES**

Parts 1, 2 and 15 of title 47 of the Code of Federal Regulations are revised as follows:

**Part 1 - PRACTICE AND PROCEDURE**

1. The authority citation for part 1 continues to read as follows:

**AUTHORITY: 47 U.S.C. 151, 154, 303 and 309(j) unless otherwise noted.**

2. Section 1.1307 is amended by revising paragraph (b)(2) to read as follows:

**§ 1.1307 Actions which may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.**

\* \* \* \* \*

(b) \* \* \*

(1) \* \* \*

(2) Mobile and portable transmitting devices that operate in the Cellular Radiotelephone Service, the Personal Communications Services (PCS), the Satellite Communications Services, the Maritime Services (ship earth stations only) and covered Specialized Mobile Radio Service providers authorized under subpart H of part 22, part 24, part 25, part 80, and part 90 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use, as specified in §§ 2.1091 and 2.1093 of this chapter. All unlicensed PCS, unlicensed NII and millimeter wave devices are also subject to routine environmental evaluation for RF exposure prior to equipment authorization or use, as specified in § 15.253(f), § 15.255(g), § 15.319(i), and § 15.407(f) of this chapter. All other mobile, portable, and unlicensed transmitting devices are categorically excluded from routine environmental evaluation for RF exposure under §§ 2.1091 and 2.1093 of this chapter except as specified in paragraphs (c) and (d) of this section.

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**PART 2 -- FREQUENCY ALLOCATIONS AND RADIO TREATY MATTERS; GENERAL RULES AND REGULATIONS**

1. The authority citation for Part 2 continues to read as follows:

**AUTHORITY: Sec. 4, 302, 303 and 307 of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154, 302, 303 and 307, unless otherwise noted.**

2. Sections 2.1091(c) and 2.1091(d) of Part 2 are revised to read as follows:

**§ 2.1091 Radiofrequency radiation exposure evaluation: mobile and unlicensed devices.**

\* \* \* \* \*

(c) Mobile devices that operate in the Cellular Radiotelephone Service, the Personal Communications Services, the Satellite Communications Services, the Maritime Services and the Specialized Mobile Radio Service authorized under subpart H of part 22 of this chapter, part 24 of this chapter, part 25 of this chapter, part 80 of this chapter (ship earth station devices only) and part 90 of this chapter ("covered" SMR devices only, as defined in the note to Table 1 of §1.1307(b)(1) of this chapter), are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if their effective radiated power (ERP) is 1.5 watts or more. Unlicensed personal communications service, unlicensed millimeter wave devices and unlicensed NII devices authorized under § 15.253, § 15.255 and subparts D and E of part 15 of this chapter are also subject to routine environmental evaluation for RF exposure prior to equipment authorization or use, regardless of their power used, unless they meet the definition of a portable device as specified in § 2.1093(b). All other mobile and unlicensed transmitting devices are categorically excluded from routine environmental evaluation for RF exposure prior to equipment authorization, except as specified in §§ 1.1307(c) and 1.1307(d) of this chapter. Applications for equipment authorization of mobile and unlicensed transmitting devices subject to routine environmental evaluation must contain a statement confirming compliance with the limits specified in paragraph (d) of this section as part of their application. Technical information showing the basis for this statement must be submitted to the Commission upon request.

(d) The limits to be used for evaluation are specified in § 1.1310 of this chapter. All unlicensed personal communications service (PCS) devices and unlicensed NII devices shall be subject to the limits for general population/uncontrolled exposure.

\* \* \* \* \*

3. Section 2.1093(c) of Part 2 is revised to read as follows:

**§ 2.1093 Radiofrequency radiation exposure evaluation: portable devices.**

\* \* \* \* \*

(c) Portable devices that operate in the Cellular Radiotelephone Service, the Personal Communications Services, the Satellite Communications services, the Maritime Services and the Specialized Mobile Radio Service authorized under subpart H of part 22 of this chapter, part 24 of this chapter, part 25 of this chapter, part 80 of this chapter (ship earth station devices only), part 90 of this chapter ("covered" SMR devices only, as defined in the note to Table 1 of § 1.1307(b)(1) of this chapter), and portable unlicensed personal communication service, unlicensed NII devices and millimeter wave devices authorized under § 15.253, § 15.255 or subparts D and E of part 15 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use. All other portable transmitting devices are categorically excluded from routine environmental evaluation for RF exposure prior to equipment authorization, except as specified in §§ 1.1307(c) and 1.1307(d) of this chapter. Applications for equipment authorization of portable transmitting devices subject to routine environmental evaluation must contain a statement confirming compliance

with the limits specified in paragraph (d) of this section as part of their application. Technical information showing the basis for this statement must be submitted to the Commission upon request.

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**PART 15 -- RADIO FREQUENCY DEVICES**

1. The authority citation for Part 15 continues to read as follows:

**AUTHORITY:** Secs. 4, 302, 303, 304, 307 and 624A of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154, 302, 303, 304, 307 and 544A.

2. Section 15.17(a) of Part 15 is revised to read as follows:

(a) Parties responsible for equipment compliance are advised to consider the proximity and the high power of non-Government licensed radio stations, such as broadcast, amateur, land mobile, and non-geostationary mobile satellite feeder link earth stations, and of U.S. Government radio stations, which could include high-powered radar systems, when choosing operating frequencies during the design of their equipment so as to reduce the susceptibility for receiving harmful interference. Information on non-Government use of the spectrum can be obtained by consulting the Table of Frequency Allocations in § 2.106 of this chapter.

\* \* \* \* \*

3. Section 15.205(a) of Part 15 is amended by removing the 5.15-5.35 GHz portion from the restricted bands table to read as follows:

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
<sup>1</sup> 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	( <sup>2</sup> )
13.36-13.41			

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

<sup>2</sup> Above 38.6

\* \* \* \* \*

4. Part 15 is amended by adding a new Subpart E to read as follows:

#### **Subpart E - Unlicensed National Information Infrastructure devices**

##### **§ 15.401 Scope.**

This subpart sets out the regulations for unlicensed National Information Infrastructure (U-NII) devices operating in the 5.15 - 5.35 GHz and 5.725 - 5.825 GHz bands.

##### **§ 15.403 Definitions.**

(a) *U-NII devices [Unlicensed]*. Intentional radiators operating in the frequency bands 5.15 - 5.35 GHz and 5.725 - 5.825 GHz that provide a wide array of wideband, high data rate, digital, mobile and fixed communications for individuals, businesses, and institutions.

(b) *Peak transmit power*. The peak power output as measured over an interval of time equal to the frame rate or transmission burst of the device under all conditions of modulation. Usually this parameter 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.

#### § 15.405 Cross reference.

(a) The provisions of subparts A, B, and C of this part apply to unlicensed U-NII devices, except where specific provisions are contained in subpart E. Manufacturers should note that this includes the provisions of Sections 15.203 and 15.205.

(b) The requirements of subpart E apply only to the radio transmitter contained in the U-NII device. Other aspects of the operation of a U-NII device may be subject to requirements contained elsewhere in this chapter. In particular, a U-NII device that includes digital circuitry not directly associated with the radio transmitter also is subject to the requirements for unintentional radiators in subpart B.

#### § 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 50 mW. In addition, the peak power spectral density shall not exceed 2.5 mW/MHz. 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 250 mW. In addition, the peak power spectral density shall not exceed 12.5 mW/MHz. 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 1 W. In addition, the peak power spectral density shall not exceed 50 mW/MHz. 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.

(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 for the emission in question over the full bandwidth of the channel.

(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. Measurements are made using a resolution bandwidth of 1 MHz. If the device can not be connected directly, alternative techniques acceptable to the Commission may be used.

(b) The peak levels of emissions outside of the frequency band of operation shall be attenuated below the maximum peak power spectral density contained within the band of operation in accordance with the following limits:

(1) For transmitters operating in the band 5.15-5.25 GHz: all emissions within the frequency range 5.14-5.15 GHz and 5.35-5.36 GHz must be attenuated by a factor of at least 27 dB; within the frequency range outside these bands by a factor of at least 37 dB.

(2) For transmitters operating in the 5.25-5.35 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge must be attenuated by a factor of at least 34 dB; for frequencies 10 MHz or greater above or below the band edge by a factor of at least 44 dB.

(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 must be attenuated by a factor of at least 40 dB; for frequencies 10 MHz or greater above or below the band edge by a factor of at least 50 dB.

(4) The above 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. Regardless of the attenuation levels shown above, emissions outside the frequency range of operation do not need to be attenuated below the general radiated emission limits in § 15.209 of this part.

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

(6) The provisions of § 15.205 of this part 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.

(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 § 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 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) The frequency stability of the carrier frequency of an intentional radiator operating under this section shall be  $\pm 10$  ppm over 10 milliseconds. The frequency stability shall be maintained over a temperature variation of -20 degrees to +50 degrees Celsius at normal supply voltage, and over a variation in the primary supply voltage of 85 percent to 115 percent of the rated supply voltage at a temperature of +20 degrees Celsius. For equipment that is capable of operating only from a battery, the frequency stability tests shall be performed using a new battery without any further requirement to vary supply voltage.

