Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Unlicensed Operation in the TV Broadcast Bands	)	ET Docket No. 04-186
	)	
Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GG\Hz Band	)	ET Docket No. 02-380
	)	

COMMENTS OF THE NATIONAL CABLE & TELECOMMUNICATIONS ASSOCIATION

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The National Cable & Telecommunications Association ("NCTA"), by its attorneys, submits the following comments on the introduction of unlicensed devices in the TV broadcast bands. NCTA is the principal trade association of the cable television industry. Its members provide video programming, broadband Internet, wireline phone, and other services throughout the United States. NCTA also represents programmers and suppliers of equipment to the cable television industry.

INTRODUCTION AND SUMMARY

NCTA supports the Commission's efforts to facilitate the development of new and innovative wireless communications devices by opening up new frequencies for the delivery of such services. The Commission's goal in this proceeding is to allow the operation of new TV band devices in the broadcast television spectrum on unused channels in locations where such operations will not result in harmful interference to TV and other authorized services. It intends the final rules to allow the marketing of TV band devices to commence on February 18, 2009, after the transition to digital television ("DTV") service is complete and all TV stations are operating on their DTV channels.

In the initial 2004 Notice of Proposed Rulemaking, NCTA brought to the Commission's attention the unique concerns of cable operators who distribute broadcast programming over their networks to consumers. In particular, we pointed out that unlicensed TV band devices could be a major source of interference to cable headend reception of distant broadcast signals and that television equipment, such as TVs and VCRs, that are directly connected to cable systems are highly susceptible to direct pickup interference from unlicensed devices in close proximity.[1] We urged the Commission to take these concerns into consideration to ensure that unlicensed transmitting devices operate successfully in conjunction with terrestrial broadcast stations, cable systems, and consumer home electronics equipment.

NCTA appreciates therefore the Commission's recognition in the First Report and Order and Further Notice of Proposed Rulemaking that it "must balance the benefits (of new TV band devices) with the need to protect authorized services in the TV bands from harmful interference" in adopting new technical rules.[2]

The Report and Order and Further Notice sets forth the basic parameters to govern the operation of fixed/access devices, and holds open the question of whether, and under what conditions, non-fixed devices (*e.g.*, personal/portable devices), should be permitted to operate in TV bands. As the Commission recognizes, personal/portable devices "generally pose a greater risk of harmful interference to authorized operations than fixed devices because such devices may have antennas that are less efficient and may be in a less advantageous position to sensing of incumbent transmissions (*e.g.*, in a room versus on a 10-meter mast), especially given that

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[1] *See In the Matter of Unlicensed Operation in the TV Broadcast Bands, ET Docket Nos. 02-380 and 04-186, Notice of Proposed Rulemaking*, 19 FCC Rcd 10018 (2004), Comments of NCTA.

[2] *In the Matter of Unlicensed Operation in the TV Broadcast Bands, ET Docket Nos. 02-380 and 04-186, First Report and Order and Further Notice of Proposed Rulemaking*, rel. October 18, 2006 at ¶ 1 ("Report and Order" and "Further Notice").

they will change location."[3] Thus, as the FCC further notes, "reliable identification of unused frequencies is substantially more difficult" for such devices and it also "may be difficult for TV and other users to locate a non-fixed device that causes interference because it frequently changes location" unlike a fixed device. We agree that personal/portable devices pose unique hazards to authorized services, but fixed devices also present special challenges to avoiding harmful interference.

With respect to the output power level of new devices, the Commission proposes a 100 mW RF output power level, with a maximum antenna gain of 6 dBi, for personal/portable devices and a 1 W RF output power level for fixed/access devices.

The Commission also proposes several methods to avoid interference, including prohibiting co-channel operation within the predicted Grade B contour of licensed broadcast stations and prohibiting adjacent channel operation by fixed/access devices within the predicted Grade B contour of licensed broadcast stations. Beyond these limitations, it seeks further comment on broader interference-avoidance schemes, notably spectrum or signal sensing by unlicensed devices to detect the presence of licensed broadcast station signals. It also raises a geo-location approach for unlicensed devices, combined with a database of authorized "white areas" where transmissions would be permitted.

As an initial matter, NCTA urges the Commission to recognize that from the cable industry's perspective TV band devices would operate on contiguous *fully activated* channels used for the reception of cable programming in the home, not in so-called vacant "white spaces." The high probability of direct pickup interference resulting from inadequate shielding in TV receivers means that without adequate protective measures, TV viewing could be jeopardized on

[3] Report and Order at ¶18.

any cable channel. Moreover, the Commission should take into account that cable operators provide more than video programming. They are major providers of high-speed Internet access and telephone services, as well as emergency information to their customers. These services too could be jeopardized by unchecked TV band devices.

In an effort to further elucidate cable's interference concerns, NCTA retained David Large, Consultants Inc. to examine the scope of the problem, based on theoretical calculations and field experience. After extensive analysis, David Large, a 33-year veteran of the cable industry, set forth in the attached paper the measures that are required to minimize interference from both fixed/access and personal/portable devices with the operations of franchised cable television operators.[4] Mr. Large's objective was to define the parameters of unlicensed TV band operation in order to avoid material degradation of the broadcast signals and other services delivered by cable, mindful of the need to adopt the least restrictive rules on new TV band devices.

Large considered several classes of interference: co-channel signals that may interfere with cable reception in the home because of inadequately shielded TV receivers (*i.e.*, direct pickup interference, or DPU) and co-channel and adjacent channel signals that may interfere with the reception of over-the-air broadcast signals at cable headends. In addition, Large addresses the alternative interference-avoidance methods and the critical issue of protecting channels 2-4.

[4] "The Potential Adverse Effects of Unlicensed Operation of New Devices in TV Broadcast Bands on Cable Customers' Reception of Cable Service," David Large, Consultants, Inc. ("Large Paper"), Appendix I.

Based on this analysis, we urge the Commission to take the following steps to ensure that unlicensed TV band devices do not interfere with cable's delivery of high quality programming and services to its customers:

1) Restrict the operation of portable devices to 10-20 mW and prohibit transmissions in the VHF channels given the high probability of direct pickup interference to TV receivers.

   This recommendation is based on the analysis of the potential for DPU interference in light of CableLabs measurements of receivers, which establish poor shielding at VHF channels. Moreover, even with receivers meeting Part 15, 47 C.F.R. § 15.118, shielding requirements, a 100 mW device will likely cause interference.

2) At a minimum, prohibit operations on channels 2-4.

   This recommendation preserves cable's ability to solve DPU interference when it arises, through use of external, well-shielded set top converters. Unlike the over-the-air situation, without the prohibition, there is no guarantee of an available "unoccupied" low-VHF channel for the converter to send signals to the receiver.

3) In order to determine whether the shielding effectiveness of television receivers has changed since a representative sample of such receivers was tested by Carl T. Jones on behalf of CableLabs, we suggest that the Commission measure a representative sample of analog and digital TV receivers to determine their ability to tolerate direct pickup interference as a function of frequency in its upcoming testing.

4) Restrict the operation of fixed devices to at least 400 feet from the external walls of residential buildings (absent a special showing that greater building attenuation justifies closer spacing), assuming UHF-only operation (greater distances would be required if any VHF transmissions were allowed). The Large analysis supports this distance requirement in order to avoid DPU from more powerful fixed devices.

5) Prohibit operation of fixed devices in VHF channels.

   The Large analysis shows that because of the increased potential for DPU interference and reduced path loss at lower frequencies which requires very

long distances between fixed devices and the cable headend (even when not in the primary beamwidth of receiving antennas), it will be very difficult to protect reception or coordinate with fixed unlicensed VHF transmitters.

6) Require spectrum coordination before operation of portable devices on channels adjacent to those being received at headends.

   The analysis shows that portable devices have the potential to cause interference to headend reception, and thus their operation should be restricted within the Grade B contour and coordinated with headends outside the Grade B boundary.

7) Of the suggested methods by which a fixed or portable device might automatically determine channel availability, it appears that auto-location (GPS or equivalent), combined with regular access to a reliable database containing geographically-indexed lists of available channels, has the potential to provide the flexibility and reliability required to protect headend reception (without unnecessarily restricting the operation of unlicensed devices).

DISCUSSION

I. THE COMMISSION SHOULD LIMIT THE POWER OUTPUT OF NEW PERSONAL/PORTABLE TV BAND DEVICES AND PROHIBIT THEIR OPERATION ON CHANNELS 2-4 GIVEN THE HIGH PROBABILITY OF DIRECT PICKUP INTERFERENCE

As NCTA discussed in its comments in the 2004 NPRM, direct pickup ("DPU") interference may occur when unlicensed devices are situated in close proximity to consumer electronics equipment in the home, including TV sets and VCRs.[5] Television receivers, VCRs and other devices connected directly to cable systems will be particularly susceptible to direct pickup interference from unlicensed devices on potentially all channels because cable operators, unlike broadcasters, use the *entire* spectrum of channels in the TV broadcast band. Thus, while an unlicensed device may in some circumstances find and operate effectively on a vacant over-the-air terrestrial broadcast, the same channel would be at risk for interference in the cable environment because there are no *vacant* channels on cable systems. Every channel in the broadcast TV band is used to deliver video programming and the fact that such programming travels over a closed transmission path does not insulate it from radiating signals which directly couple with receivers' internal circuitry due to its imperfect shielding.

Therefore, the first premise that we urge the Commission to recognize in analyzing the impact of unlicensed TV band devices from the cable industry's perspective is that such devices would operate on *fully activated* channels used for the reception of cable programming in the home, not in so-called "white spaces." In addition to video programming, cable also delivers

[5] Section 2.1(c) of the Commission's rules, harmful interference is defined as "interference which . . . seriously degrades, obstructs, or repeatedly interrupts a radio communication service operating in accordance with these [international] Radio Regulations. 47 C.F.R. § 2.1 (c).

emergency alert messages, local news and information, as well as telephone and high-speed Internet data services.

Second, in light of this fact, we believe the Commission should give greater weight to the concern about direct pickup interference. In the NPRM, the Commission relies on Intel's unsubstantiated assertions that direct pick up interference from personal/portable TV band devices is "highly improbable" because newer TVs and set top boxes incorporate fully shielded tuners that are "nearly invulnerable" to direct pick up interference and that operators of personal/portable devices in close proximity to affected TV receivers could simply "reconfigure, relocate or disable their equipment to avoid direct pickup interference."[6] The Commission also discounts interference concerns on the grounds that "such devices are typically under the control of the same party who can increase the separation distance between them or cease operating a device to eliminate any interference that occurs."[7] It further wrongly suggests that the cabling between a TV interface device and a TV receiver may be inadequate to prevent the ingress of unwanted signals on channels 2-4, when inadequate shielding in the TV receiver is the source of the problem. As discussed below, we take issue with each of these points.

While Intel dismisses interference concerns on the assumption that newer TVs and set top equipment are virtually immune from interference because of fully shielded tuners, there is nothing in the record of this proceeding to substantiate this claim. Part 15 of the FCC's rules, 47 C.F.R. § 15.118, provides a minimum shielding standard that applies to digital and analog receivers (and other receiving equipment such as VCRs) only if they are specifically marketed as

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[6] Further Notice at ¶62.

[7] Further Notice at ¶63.

"cable ready" or "cable compatible" equipment.[8] These receivers have an extended tuning range that enables direct connection to cable systems without the use of a set top converter. There also are TV receivers in use today with and without extended tuning range that are not subject to the shielding standard in the rules. Since the standard was adopted, the cable industry has sought more stringent shielding requirements to protect against signal ingress but the Commission has declined to take such action (or to apply the rules to all extended tuning range analog receivers). In the meantime, millions and millions of receivers have been manufactured and sold in which the level of shielding built into the set meets the minimum Part 15 standard or is unknown because the equipment is not covered by the rules.

But there is no evidence in the record, and as far as we know it has never been established, that *newer* television sets have incorporated significantly upgraded shielding to protect against interference. And as we discuss more fully below, whether or not some newer sets have improved shielding, most of the TV sets in operation in consumers' homes today would be highly vulnerable in many situations to direct pickup interference based on available test data.

Indeed, the scope of potential direct pickup interference is quite profound given the long life expectancy of analog sets. We estimate that there are approximately 130 million analog television sets in cable households today (and approximately 93.9 million video cassette recorders).[9] Even in the event that many of these sets meet the 100mV/m standard for shielding

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[8] 47 C.F.R. § 15.118.

[9] NCTA estimate based on Nielsen Media Research and Kagan Research data; *see also* Letter to Honorable Carlos Gutierrez, U.S. Secretary of Commerce from Kyle McSlarrow, President and CEO, National Cable & Telecommunications Association, October 31, 2006 (concerning the transition from analog to digital television).

analog cable ready receivers from direct pickup interference under Part 15, the signal strength (1 Watt for fixed devices and 100 milliwatt for personal/portable devices) will exceed that immunity standard.[10] Given the enormous embedded base of TV receivers and VCRs, it would be unwise for the Commission to authorize new unlicensed TV band devices without giving the potential for wide-scale direct pickup interference and its adverse impact on cable customers adequate attention.

Based on the foregoing discussion, interference test data submitted to the Commission by CableLabs in the cable compatibility proceeding that arose out of the 1992 Cable Act is still relevant and useful in this proceeding.[11] CableLabs, at the request of the NCTA/EIA Joint Engineering Committee (JEC), engaged Carl T. Jones to conduct studies of DPU interference on 35 television sets, a representative sample of various manufacturers and models. In analyzing shielding effectiveness as a function of the selected signal frequency, the tests showed that the higher up the TV band, the more effective the shielding. The study also demonstrated, in particular, that the television receivers provided very poor shielding protection at the low VHF channels.[12]

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[10] The Consumer Electronics Association's ("CEA") "Test Plan for Unlicensed Operation in TV Bands," demonstrates the allowed signal strength from unlicensed devices is likely to exceed the 100mV/m direct pickup immunity specified for analog cable-ready devices in Section 15.118, *Ex Parte presentation submitted by CEA, ET Docket No. 04-180, 02-380*, October 14, 2004. Furthermore, as discussed in the Large Paper, due to the generally lower signal levels at which digital programming is received by cable customers' receivers, digital programming will experience interference at lower levels than analog programming.

[11] *See In the Matter of Compatibility Between Cable Systems and Consumer Electronics Equipment, ET Docket No. 93-7*, Comments of Joint Filers, CableLabs Report, "Customer Premises Equipment Performance and Compatibility Testing," Section 3 (Carl T. Jones Corporation Study) ("Carl T. Jones Study") attached as Appendix II.

[12] *See* Carl T. Jones study.

In the attached paper, David Large analyzed the shielding data from the Jones study as it pertains to the operation of unlicensed devices in the TV broadcast bands. He concluded the following:

> Based on the characteristics of the signals received and the shielding effectiveness of most receivers, simple field strength calculations show that portable devices, as proposed, will have a high probability of causing interference on any VHF or UHF channel to a receiver located in the same room. Furthermore, the probability of causing interference to a receiver in an adjoining apartment (assuming a typical wood-frame intervening wall) is very high at 100 mW transmit power. If the power is reduced to 20 mW, then the required spacing between device and receiver is reduced to approximately 60 feet for protection of digital signal reception and about 25 feet for protection of analog signal reception.
>
> Similar calculations for externally-mounted, fixed/access, one watt unlicensed devices (taking into account that the signal must pass through at least one exterior wall) suggests that a 400 foot spacing from the nearest residence is adequate for protection of both analog and digital signal reception, and that closer spacing may be possible in cases of masonry or similar higher-attenuation construction.[13]

The Commission's reliance on consumer control and ability to eliminate interference by moving the device seems to accept that interference will occur but it is the responsibility of the consumer to ameliorate it. It takes the view that the distance between the TV receiver and the unlicensed device is not a concern because it is controllable by the customer.[14] However, as shown in Figure 1, even in a single family home, the distance that the consumer would have to maintain between the device and the TV receiver to ensure non-interference is so significant as to be impractical.[15] Furthermore, many people reside in apartments in multi-dwelling buildings where they share common walls. Such persons could be subjected to a degraded picture on their

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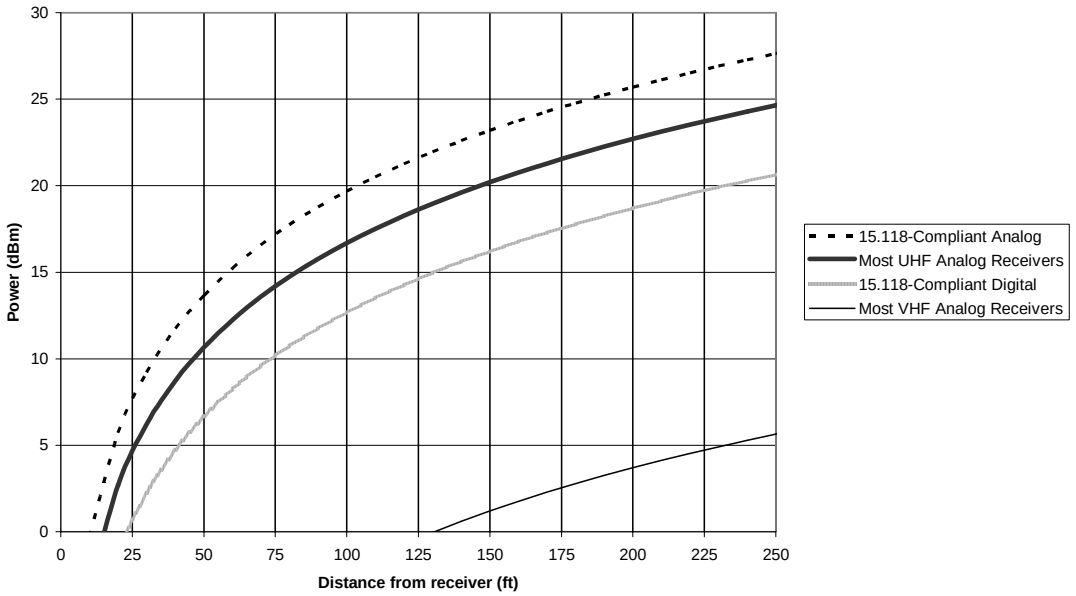
[13] Large Paper at 4. The adjacent apartment conclusion was based on the assumption that all receivers meet the shielding requirement of § 15.118 (which, as shown by CableLabs' results, is unlikely) or, as applies to both portable and fixed operation, that operation is restricted to UHF channels only. If operation is allowed on VHF channels, the potential for interference is significantly increased.

[14] Further Notice at ¶63.

[15] Large Paper at 6, Table 2.

TV set resulting from a portable device being operated by a neighbor in an adjacent apartment – whose actions they have *no control* over.

Figure 1: Transmit Power(dBm) vs Distance to Receiver for Maximum Tolerable DPU Reception Interference Based on Free-Space Transmission and 6 dBi Unlicensed Device Antenna Gain



The detection methods proposed by the Commission, such as signal sensing, geo-location or control signal approaches, would have no impact in alleviating direct pickup interference because an unlicensed device utilizing one of these detection methods will locate and transmit on a *vacant* over-the-air terrestrial broadcast channel, which is *not* vacant on cable. The only way to avoid such interference is to impose a limit on the maximum allowable power output of the device and to preclude transmission on TV channels 2-4. Retaining a certain distance between the unlicensed device and the television receiver would also work but this solution, as noted above, is impractical, particularly in multi-dwelling residential units. As Large explains, "a limitation on maximum allowable power must be provided to assure that the field strength of the unlicensed device is not sufficient to cause degraded reception, especially in cases where the

receiver and unlicensed device are not under common ownership or control, as, for example, in the case of adjacent apartments."[16]

In sum, the cable industry urges the Commission to avoid an overly simplistic and overly optimistic approach to potentially harmful direct pickup interference.[17] Cable customers expect their cable company to deliver clear, interference-free programming for viewing on their TV sets and VCRs. They will not tolerate unreliable, intermittent cable service and will turn to their operator to fix the problem wherever the interference is coming from. And particularly in the case of portable devices, the cable operator will be at a loss to rectify the situation if the source of the problem cannot be identified and controlled.

Therefore, NCTA urges the Commission to ensure that such problems do not occur by adopting a maximum power output in the range of 10-20 milliwatt for portable TV band devices. As Large shows, the output power proposed by the Commission (100 mW for personal/portable devices) poses significant interference concerns for the cable industry.

Interference on channels 2-4

In the NPRM, the Commission seeks further comment on its proposal to exclude low power TV band devices from operating on TV channels 2-4 to avoid possible interference to TV interface devices such as VCRs, DVDs, and cable set top boxes that operate on or adjacent to those channels. As the Commission is aware, channels 2, 3 and 4 are vital to cable network

[16] Large Paper at 4.

[17] The Commission asserts that "fixed TV band devices will typically not be operated as close to TV receivers as some parties assume and should not generally cause interference problems." Based on Large's analysis, a distance requirement of at least 400 feet from the external walls of residential buildings (absent a special showing that greater building attenuation justifies closer spacing), assuming UHF-only operation, is required for operation of fixed devices to avoid DPU interference.

operations because the tens of millions of set top boxes that are connected to consumers' television receivers and VCRs convert all programming to one of those channels for display on the set. Set-top box converters are the primary mechanism for cable systems to guard against ingress from interfering signals. The low-VHF channels are used because typically one or more are not assigned to a local over-the-air broadcast station.

As with the broader direct pickup problem discussed above, the concern with protecting channels 2-4 arises out of the need to preserve the ability to compensate for inadequate shielding in the television receiver. Even with the spacing and power levels advocated above, there is still a risk that interference will occur on any channel. The solution to such interference is to install a well-shielded set top converter which converts the incoming signal to a channel not used for local broadcast transmission, typically 2, 3 or 4. As Large explains, the analysis of the test data conclusively demonstrates that "DPU will be a problem where unlicensed devices are operated in the same room as television receivers and will potentially be a problem to reception in adjacent apartments or duplex residences, even when operation is restricted to UHF and/or where analog receivers fully comply with the requirements of §15.118 with respect to shielding."[18] He further notes:

> As demonstrated by the Carl T. Jones measurements on actual production receivers, many (and perhaps most) deployed analog receivers are seriously lacking in shielding at channel 6 and below, with the result that interference radii from unlicensed devices transmitting on VHF, and especially low-VHF, channels will likely extend throughout adjacent apartments.[19]

The Commission suggests that the issue is whether the cabling between a TV interface device and a TV receiver is adequate to prevent the ingress of unwanted signals on channels 2-4.

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[18] Large Paper at 18.

[19] *Id.*

But the cabling is not the source of the problem. It is the inadequate shielding in the TV receiver described above. And it is important to note that DPU interference from the operation of unlicensed devices, particularly personal/portable devices, will affect not just a few channels but *all* program services because the set top box converts all program services to channels 2, 3 or 4 for display by the TV set.

Moreover, as noted above, there are over 130 million analog-only receivers in U.S. cable households today and most of them will still be in operation after February 2009. Many of these sets will be connected to set-top converters using an analog RF signal on channel 2, 3 or 4 as the only available input. While digital cable ready sets are increasingly being sold in the marketplace, they are not immune from the direct pick up problem. Set top box converters configured for a channel 2, 3 or 4 output will continue to be an important safety valve for cable operators to address cases of direct pick up interference.

Therefore, with the proliferation of television receivers in the consumer marketplace with insufficient shielding characteristics, it is critical, at a minimum, for the Commission to protect channels 2-4 from the effects of unlicensed TV band devices by prohibiting operation on those channels.

II. THE COMMISSION SHOULD RESTRICT OPERATION OF PERSONAL/PORTABLE DEVICES WITHIN THE GRADE B CONTOUR AND REQUIRE SPECTRUM COORDINATION BEFORE SUCH DEVICES ARE PERMITTED TO OPERATE OUTSIDE THE GRADE B BOUNDARY GIVEN THE POTENTIAL FOR CABLE HEADEND INTERFERENCE

Cable Headend Reception Interference

In the initial Notice, NCTA cautioned the Commission about authorizing unlicensed TV band devices because of potential interference to cable headend reception of over-the-air broadcast signals. Although cable companies sometimes have direct links to television stations,

many cable systems receive terrestrial broadcast signals through tower-mounted, high gain directional terrestrial antennas, particularly in fringe areas. Cable systems then combine the terrestrially-delivered broadcast programming with satellite-delivered cable programming for retransmission over the cable network to the customer.

The Commission proposes to protect broadcast stations from interference within certain defined contours, depending on the type of station and the frequency band in which the station operates. It relies on the methodology adopted for digital television. In most cases, the protected area is the Grade B contour. While broadcast signals are generally received at the cable headend within the Grade B contour, and therefore would be protected under the proposed rules, there are many instances where broadcast signals are received at cable headend locations outside of the Grade B contour. And cable operators are required to carry many of these "distant signals" because they are "must carry" signals pursuant to the Commission's rules.[20]

The Commission's emphasis on protecting a defined area around a broadcast transmitter arguably makes sense for broadcast stations, but it does not address cable's interference concerns. For cable operators, as discussed above, the relevant reference point is the cable headend *receive* site, not the broadcast transmitter. If broadcast signals are only protected within the predicted Grade B contour, unlicensed TV band devices will be free to transmit within the beam width of the headend receiving antenna used to receive distant signals beyond the Grade B contour.

As Large explains, "any unlicensed transmitter, portable or fixed, that is positioned between the headend and the digital television ("DTV") station and within the primary beamwidth of the receiving antenna and which transmits on a channel that is being received at a

[20] 47 C.F.R., Part 76, Subpart D.

cable system headend will cause an unacceptable degree of interference to reception of the DTV station."[21] These interfering signals will in turn subject cable customers to degraded picture quality on the channel carrying the distant station. And this type of interference will affect not just isolated customers but numerous customers throughout the cable system. Furthermore, assuming personal/portable TV band devices proliferate, cable operators will be unable to identify the source of the interference and unable to meet their obligation to deliver a "must carry" signal without material degradation.

This whole scenario runs counter to the Commission's intention to avoid authorizing new communications devices and services that may interfere with established authorized services. And, as a policy matter, the desire to protect primary users' communications – by prohibiting secondary users from materially degrading the primary service – should apply equally to cable systems, whether the broadcast signal received is inside or outside of a defined contour.

However, as the proposed rules currently stand, unlicensed TV band devices will be permitted to transmit on channels used to receive distant broadcast signals. Unless the Commission adopts certain restrictions on the operation of such devices, as described below, there is a strong likelihood of interference with local broadcast signals received by cable from outside the protected contour, particularly in rural markets.

David Large Consultants quantified the extent of potential interference from fixed and personal/portable TV band devices. Large found the following:

> Assuming that received levels at headends that are 11 dB above the threshold for DTV receivers (as defined in ATSC A/74) and, further, allowing a level of interfering signal that will cause a D/U of 23 dB and decrease the operating margin by 3 dB, the required distance between unlicensed transmitters and headends in order to avoid interference is significant. For any device located in the primary beamwidth of the receiving antenna, the required path loss is

[21] Large Paper at 25.

equivalent to a free-space distance of at least *200 miles*. For devices located outside the primary beamwidth, the distances are shown in Table 1:

Table 1: Minimum Off-Axis Distance Between Unlicensed Co-Channel Transmitter and Headend (in miles) to Assure Interference-Free Reception

Unlicensed Device Power	Channel 2	Channel 7	Channel 14
100 mW	87	38	14
1W	274	120	44

These long distances are a direct result of the relatively low signal levels encountered in digital television reception, as compared with analog reception: -45 dBm is considered a usable signal for analog, while digital signals may routinely be below -70 dBm at the input terminals of processing equipment. Since headends located beyond the predicted Grade B contour often use very high towers and/or take advantage of exposed hilltop locations, free-space path loss assumptions may well be appropriate for distances out to at least 50 miles. Based on these results, required protection areas around headends for fixed devices on any VHF channels and portable devices on low-VHF channels will be very large.

Large's analysis shows that personal/portable TV band devices have the potential to cause interference to headend reception, and that even portable devices that transmit on adjacent channels within the beam width of headend receiving antennas can cause interference for a considerable distance. Thus NCTA urges the Commission to restrict such devices within the Grade B contour and to require spectrum coordination with headend operations outside the Grade B boundary. Such coordination is also essential before personal/portable devices are permitted to operate on channels *adjacent* to those being used to receive distant broadcast signals at cable headends.

Interference Avoidance Methods

In the Further Notice, the Commission seeks ways to avoid interference in a manner that

will promote the least restrictive operation of new TV band devices. It considers several interference avoidance methods, including the use of spectrum sensing, geo-location/database or control signal approaches, as the means to determine the availability of unused frequencies in the TV bands. NCTA believes that these detection methods, standing alone, would be inadequate and ineffective in ensuring interference-free operation of TV band devices.

As Large explains, spectrum or signal sensing:

> "suffers from the wide variation in signal levels over small distances, particularly in fringe areas, that would require an extreme sensitivity that, even if practical, would often forbid transmissions in many cases where potential interference would not occur. That is particularly true in headend reception cases, where cable's antennas might be located hundreds of feet in the air while the off-air signal is virtually undetectable near the ground."[22]

A level even 30 feet above the ground is undetectable or extremely low. In the case of unlicensed radiators which are located to the side or rear of the receiving antenna, Large concludes that the required distance between the device and the headend is significant:

> What these calculations show is that <u>low-VHF receiving locations may be impractical to protect from even 100 mW co-channel unlicensed transmitters due to the low path-loss attenuation as a function of distance, while high-VHF operation may be practical for 100 mW devices and UHF operation may be practical for devices with power levels up to 1 W, provided adequate means can be found to define and protect receiving locations</u>.
>
> As the above analysis shows, unlicensed devices operating at levels as low as 100 mW have the potential for creating interference, even if prohibited from either co-channel or adjacent channel transmission within the predicted Grade B contours of DTV stations. Furthermore, as is well known to the Commission and borne out by many years of experience:
>
> - Television signals do not respect "predicted contour" levels. Many places within the contour boundaries have much lower than predicted levels, while signals may be received at Grade B reference levels or beyond well beyond the predicted contour boundary.

[22] Large Paper at 6.

- Both consumers and headends regularly receive signals beyond the predicted contour boundaries, either because of favorable signal paths, and favorable locations utilized or because (especially in the case of cable) tall towers are constructed to access signals which are not usable at lower elevations.[23]

In sum, "the variability of signal transmission, combined with the sometimes-extreme measures taken by cable operators to receive adequate signals, make signal sensing a poor technology for determining available spectrum for unlicensed device transmission."[24]

Similarly, the use of a beacon signal to signify available channels, suffers from the same malady – that its transmission boundaries are difficult to predict and impossible to control. Indeed, there is no well-defined boundary beyond which the signals from the beacon signal transmitter will not be receivable. As Large points out, "even nominally line-of-site VHF and UHF signals have very irregular actual service areas that do not approximate Predicted Grade B Contours except in areas without hills or significant buildings."

The last approach proposed by the Commission would require unlicensed TV band devices to essentially auto-locate, such as through the use of GPS or equivalent technology. This method holds promise but, as Large explains, it would have to be combined with access to a reliable database containing information on eligible channels as a function of location in order to protect headend reception without unnecessarily restricting the operation of unlicensed devices. This method of coordinating between operation of unlicensed devices (either fixed or portable) and headend receiving facilities may be feasible, but requires further study.

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[23] Large Paper at 29.

[24] Large Paper at 30.

CONCLUSION

In light of the foregoing analysis, NCTA urges the Commission to adopt technical rules that take full account of the ramifications of unlicensed operation of fixed or personal/portable TV band devices on cable television systems which tune channels across the entire broadcast spectrum. We believe the rules should restrict the power output of all TV band devices, particularly personal/portable devices; prohibit operation on VHF channels, particularly low-VHF channels; and, at a minimum, protect channels 2-4 to ensure that cable operators may continue to utilize set-top converters to address interference problems in cable households.

Respectfully submitted,

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