Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

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

To: The Commission

JOINT COMMENTS OF
THE ASSOCIATION FOR MAXIMUM SERVICE TELEVISION, INC.
AND THE NATIONAL ASSOCIATION OF BROADCASTERS

November 30, 2004

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SUMMARY

The Association for Maximum Service Television, Inc. (MSTV) and the National Association of Broadcasters (NAB) urge the Commission to revisit both the timing and substance of the proposal to allow unlicensed devices to occupy the band on which the public receives its free and universal over-the-air television service. That proposal would produce many detrimental and unintended consequences to America's free, over-the-air television service, but fails to present any meaningful method for resolving such problems. The public would be ill-served by its adoption.

While the harmful interference that would be created by unlicensed devices would be of concern at any time, it is particularly troubling during the transition to digital television, which is at a crucial but fluid point in its development. Because digital technology is an "all or nothing service," the "early adopters" with digital television sets will see a blank screen when experiencing harmful interference from unlicensed devices. If digital service is branded "unreliable," other consumers will be less inclined to adopt DTV technology. In light of the substantial investments made to date in the digital transition – throughout both the public and private sectors – the Commission should not risk the health of the digital transition for what are, at best, speculative gains in the market for unlicensed devices.

Furthermore, whether during or after the transition to digital transition, interference from the indoor operation of portable unlicensed devices would prevent the average American from watching free-over-the-air and possible even cable television *on any channel*. As demonstrated in the attached study prepared by Communications Research Centre Canada, this effect would occur throughout the United States as a result of desensitizing interference to the television set, and is irrespective of whether the unlicensed device has found an "empty" television channel.

The Notice also fails to provide any practical means to prevent unlicensed devices from creating harmful interference by operating on frequencies used to deliver broadcast signals to the public. The proposals it does identify rely on technology which has not yet been sufficiently developed, or on methods which have already proven unreliable. The American public depends on television as its number one source of news and information. The techniques for preventing interference to this service from millions of unlicensed devices must be foolproof, and those proposed in the Notice do not remotely meet this standard. And once the unlicensed devices create interference to the public's television service, broadcasters and the Commission would have no effective means of stopping them.

Allowing such dramatic harm to the public's television service would be particularly misguided given the dearth of so-called "white spaces" in well-populated areas during the digital transition. As detailed in the attached engineering analysis, during the complicated channel election and repacking process involving 1600 full-power television stations and their analog and digital channels (not to mention thousands of Class A, LPTV, translator, and booster stations), the environment in which unlicensed devices would operate would be crowded, shifting, and uncertain. It is thus not even in the interest of the spectrum sharing overlay concept to launch it in this, the worst possible environment, where the damage could be extensive and irreparable, and where its benefits would be so marginal.

Compounding these serious flaws, the Notice's proposals are vague and ill-defined, and do not even consider the relative benefits of other options, such as *licensed* white space spectrum. The Commission has not provided specifics about the nature, operation, and features of the proposed unlicensed device proposals. Thus, debate over such important specifics

has been impossible, raising serious questions about the adequacy of the record and the prudence of the Commission's proceeding to a decision.

The Commission, Office of Engineering and Technology (OET), and the Spectrum Policy Task Force should be praised for their efforts to cultivate spectrum more intensively, using various advanced technologies. But the worthiness of the objective should not lessen the standard of care that must be brought to bear on their authorization. Unfortunately, that would be the result were the Commission to adopt, absent significant revision, the proposals set forth in the Notice.

Accordingly, MSTV and NAB urge the Commission to, at a minimum, defer the introduction of any new shared uses for the public's broadcast television spectrum until after the conclusion of the digital transition. If at that time the Commission still sees a need for overlay operation in the television broadcast spectrum, it should design, articulate, test, and solicit public comment on a new proposal with well-defined and predictable parameters for the protection of the public's free, over-the-air television service.

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In its present form, the proposal to allow unlicensed devices to operate in the television broadcast band would, among other public interest harms, disrupt the transition to digital television in which viewers have such an important stake. Rather than sacrificing the health of the digital transition, the Commission should conduct further study of the technologies involved and at a minimum wait until the transition is complete before burdening and jeopardizing the broadcast television spectrum with new shared uses. Regardless of timing, the unlicensed devices proposal should not be implemented to the extent that it allows mobile device operation, which would cause unprecedented and uncontrollable levels of interference to television sets.

Engineering studies commissioned by the Association for Maximum Service Television, Inc. (MSTV) and the National Association of Broadcasters (NAB)[1] call into question two fundamental assumptions on which the Commission's *Notice of Proposed Rulemaking*

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[1] *Infra,* Ex. 1, Victor Tawil and Charles W. Einolf, Jr., Ph.D., *Interference from the Operation of Unlicensed Devices in the Broadcast TV Bands* ("MSTV/NAB Engineering Study").

(Notice) is based: First, that unlicensed device operation under the proposed parameters will not cause harmful interference to the public's free, over-the-air television service, and second, that there is available "white space" for unlicensed uses prior to the conclusion of the digital transition.[2] Because the engineering realities disprove these assumptions, adoption of the Notice's proposal would result in harmful interference to television viewers without providing meaningful new access to spectrum for unlicensed devices in populous areas. And although consumers and broadcasters would theoretically have a right of enforcement against the offending unlicensed devices, the Notice's proposal offers no practical means to protect the public's television service by exercising that right.

Accordingly, MSTV and NAB urge the Commission to revisit the parameters and timeline of its proposal so that any new access to the television broadcast spectrum is achieved without harmful disruption to the digital transition and the public's ability to access free, over-the-air television.[3] Any new plan should also consider the effects of unlicensed use on other licensed spectrum stakeholders as well as the relative benefits of licensing any truly "white space" spectrum, which might yield greater public interest benefits and mitigate the potential for interference to television viewers. Without such careful study, the Commission cannot justify the risks posed by unlicensed device operation in the broadcast spectrum.

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[2] *Unlicensed Operation in the TV Broadcast Bands*, Notice of Proposed Rulemaking, ET Docket No. 04-186, FCC 04-113 (rel. May 25, 2004) ("Unlicensed Devices NPRM").

[3] MSTV is a non-profit trade association of local broadcast television station committed to achieving and maintaining the highest technical quality for the local broadcast system. NAB is a non-profit, incorporated association of radio and television stations that serves and represents the American broadcast industry.

I. ADOPTION OF THE NOTICE'S UNLICENSED DEVICE PROPOSAL WOULD COME AT THE EXPENSE OF THE TRANSITION TO DIGITAL TELEVISION.

The Commission should not attempt to introduce unlicensed devices into the television broadcast frequencies prior to the conclusion of the digital transition. If the Commission proceeds with the unlicensed devices proposal described in the Notice, it will face a tension between two competing goals – the promotion of a successful transition to digital television and the opening up of spectrum below 1 GHz to unlicensed devices. By attempting to achieve both goals simultaneously, the Commission risks failure on both fronts. Instead, it should focus on bringing the digital transition to a successful conclusion and, only then, on any potential new shared uses of the television broadcast spectrum.

If unlicensed devices are allowed to cause harmful interference to digital television services, the high-priority (and high-profile) transition to digital television will falter. As Commissioner Martin noted in his partial dissent to the Notice of Inquiry concerning the Notice's proposal, "opening this inquiry into the TV broadcast bands at this time may create additional uncertainty and potentially delay the digital transition."[4] DTV is an all-or-nothing technology; loss of service means not just a poor picture, but no picture at all.[5] If consumers are subjected to harmful interference from unlicensed devices – even if such interference could

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[4] *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, Notice of Inquiry, 17 FCC Rcd 17003 (2002) (Separate Statement of Commission Kevin J. Martin, Approving in Part and Dissenting in Part) ("Unlicensed Devices NOI"); *see also* Unlicensed Devices NPRM, Statement of Commissioner Jonathan S. Adelstein ("[I]t is worrisome that we are undertaking this proceeding right in the middle of our important digital television transition. I have lingering concerns about the wisdom of allowing unlicensed operations in the vacant television bands before the DTV transition is complete, and I encourage commenters to fully address this timing issue and any problems that it creates.").

[5] *See* Joint Comments of MSTV and NAB, ET Docket No. 02-380 (filed Jan. 27, 2003) ("MSTV/NAB NOI Joint Comments").

eventually be corrected – they will see a frozen picture or blank screen. Such disruption could easily derail the digital transition, which is currently at a critical juncture in its development.

Congress, the Executive Branch, and the Commission have all made clear that bringing the digital transition to a successful conclusion is of utmost priority and that it should not be obstructed by lower-priority goals, no matter how laudable they may be.[6] For example, the Commission has found that despite their public interest value, new digital low power television (LPTV) stations should not be allocated at the expense of the full-power DTV transition. The Commission rightly decided that "lacking sufficient spectrum, we were unable to award second channels to TV translator, LPTV, or Class A stations to facilitate their digital transition."[7] More generally, the Spectrum Policy Task Force (SPTF) in its seminal 2002 Report observed that "[i]n the case of broadcasting, evolution towards greater flexibility is governed for the time being by the statutorily-mandated DTV transition process, making additional regulatory

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[6] *See, e.g., FCC May Seek Comment Soon on DTV Transition Plan, Ferree Says*, TR Daily, May 12, 2004 (quoting Media Bureau Chief Kenneth Ferree as describing the DTV transition "as important, if not the most important thing the FCC will do while I am here."); *FCC Bureau Chief Confirm DTV Conversion Pressure*, Satellite News, Oct. 11, 2004 (quoting Mr. Ferree, "The rate of transition to digital television will continue to accelerate, and it is probably the single most important project for the Media Bureau during the next 12 months."); *DTV Transition Top Priority for NTIA*, TR Daily, April 30, 2004 (quoting John Kneuer, counselor to the acting National Telecommunications and Information Administrator, "the administration is committed to seeing [the digital] transition happen with as little disruption as possible to consumers."); H.R. Rept. 107-481, § 531 (2002) (identifying as a goal "accelerating the digital television transition.").

[7] *See, e.g., Amendment of Parts 73 and 74 of the Commission's Rules to Establish Rules for Digital Low Power Television, Television Translator, and Television Booster Stations and to Amend Rules for Digital Class A Television*, Report and Order, FCC 04-220, MB Docket No. 03-185, at ¶ 15 (rel. Sept. 30, 2004) ("Indeed, we do not expect spectrum for new low power digital operations, as 'companion' channels for existing analog programming services, to become available until TV channels are surrendered by full-service stations at the end of the full-service DTV transition period."). Of course, the introduction of unlicensed devices into the television broadcast spectrum would also run counter to the Commission's plans to "hasten the transition of LPTV and TV translator stations to digital operations." *Id.* at ¶ 1.

changes impractical at least until that process is complete."[8] Accepting the risks created by the introduction of unlicensed devices to the broadcast television spectrum during the digital transition would run directly counter to these bedrock policy goals.

With all the public and private resources invested over the past two decades, sacrificing the digital transition for speculative gains in unlicensed technologies would be a mistake. Years of hard work by broadcasters, government officials, consumer electronics manufacturers, and others have seen considerable progress, with approximately 1200 out of 1600 television stations in the nation's 208 television markets now broadcasting a digital signal.[9] With the transmission side of the equation – broadcast facilities – virtually complete, the critical factor is to create incentives for American consumers to turn off their analog television receivers and switch to receiving signals in a digital format. Although there are many factors which still must be addressed to ensure success on the consumer acceptance front – such as the cost of DTV receivers and converter boxes – the introduction of interfering unlicensed devices would be a serious setback to this key component of the transition.

If harmful interference from unlicensed devices were to derail the digital transition, local consumers would lose out on the many public interest benefits of digital television, which the Commission has described to the public as "a new type of broadcasting technology that will transform television as we now know it."[10] Of equal importance, the

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[8] Report of the Spectrum Policy Task Force, ET Docket No. 02-135 (Nov. 2002) ("SPTF Report").

[9] *Mass Media Notes*, Communications Daily, Feb. 26, 2004 (quoting an NAB spokesperson as reporting 1,155 local stations on air in digital). That number has presumably risen in the nine months that have passed since NAB's report.

[10] FCC, *Digital Television – Get It – Tomorrow's TV Today!*, FAQ, *available at http://www.dtv.gov/consumercorner.html*.

Commission's action would delay the return of 24 MHz of out-of-core spectrum for interoperable public safety uses, identified as a priority by the 9-11 Commission Report and, subsequently, by Congress.[11] Entrepreneurs of licensed broadband services, who are awaiting the reallocation of 84 MHz of out-of-core spectrum for new commercial uses, would also suffer if the digital transition were undermined by the introduction of unlicensed devices. Of course, these are just a few of the stakeholders who would be negatively impacted by adoption of the Notice's proposal.

A related problem with the timing of the Notice's proposal is that it does not allow for the development of proper engineering safeguards and standards for the new devices before they are allowed to operate in the television broadcast spectrum. This uncertainty over technical standards adds to the risk created by the addition of unlicensed devices to the already-crowded television broadcast spectrum during the digital transition. Accordingly, the Commission should, at a minimum, find that no new uses of the television broadcast spectrum may be introduced until the conclusion of the digital transition.

II. OPERATION OF UNLICENSED DEVICES UNDER THE PARAMETERS PROPOSED BY THE NOTICE WOULD CAUSE HARMFUL INTERFERENCE TO BOTH ANALOG AND DIGITAL TELEVISION RECEPTION.

The fundamental prerequisite of the Notice's proposal – that unlicensed device operation in the television broadcast spectrum must not cause harmful interference – has not been met.[12] As the Commission's NPRM acknowledges, "Because unlicensed broadband

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[11] *See* The 9/11 Commission Report, Final Report of the National Commission on Terrorist Attacks Upon the United States at 292-93 (2004) ("[O]fficers from some PAPD commands lacked interoperable radio frequencies. As a result, there was no comprehensive coordination of PAPD's overall response.").

[12] Unlicensed Devices NPRM at ¶ 15 ("[W]e believe that with appropriate safeguards it would be possible to allow unlicensed operation in the TV bands without causing new harmful interference (continued...)

devices would share spectrum with broadcast TV and other licensed services, they would need to have capabilities to avoid causing harmful interference to licensed services in the TV band."[13] Yet such harmful interference would occur for two reasons. First, when portable unlicensed devices using the television broadcast spectrum are operated indoors, they will prevent consumers in the average American home from watching television on any channel – whether over the air or on cable. This effect is a result of desensitization[14] to the television set or ingress interference to the cable connecting the consumer to MVPD services; it is unrelated to the ability of the portable device to find an available television channel. Second, for both portable and fixed devices – whether operated indoor or outdoor – there is not, in fact, a reliable mechanism for determining whether a television channel is truly "vacant" in a given area.[15] And the Notice's proposal does not provide a dependable means for remedying harmful interference once it occurs. Adoption of the Notice's proposal would thus interfere with the public's access to both analog and digital television services.[16]

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to television services."); *OET Chief Sees Potential Solution for "White Spaces" TV Proposal*, Communications Daily, April 19, 2004 (Quoting Office of Engineering & Technology Chief Edmund Thomas as stating that the unlicensed devices proposal is "design[ed] … in such a way [that] it doesn't create interference for the TV broadcasters in the channels that are used.").

[13] Unlicensed Devices NPRM at ¶ 17.

[14] Desensitization reduces the dynamic range (*i.e.*, the range by which a receiver is able to pick up a TV signal) of a television receiver on any channel.

[15] Also, broadcasting's "open architecture" makes television reception uniquely susceptible to interference. Television broadcasters do not own, control, or manufacture television receivers. As a result, if interference occurs, broadcasters lack the ability to "fix" television sets in consumers' homes to adapt to the new interference. And television broadcasters have no ability to require consumer electronics manufacturers to include additional interference immunity protection into new television receivers.

[16] MSTV and NAB note that the Notice's proposal has also raised significant concern among public safety advocates. *See, e.g.*, Comments of the Association of Public-Safety Communications Officials-International, Inc., ET Docket No. 04-186 (filed Nov. 29, 2004).

A. As Demonstrated In The Attached Technical Study, Operation Of Portable Unlicensed Devices As Proposed By The Commission Would Effectively Prevent Viewing Of Free, Over-The-Air Television And Even Cable Television In Many American Households.

The attached technical study (Exhibit A, Appendix 1), prepared by Communications Research Centre Canada (CRC Study) for MSTV, demonstrates that operation of portable devices in the television broadcast spectrum under the Notice's proposed technical parameters will cause both analog and digital television sets to go blank on all channels of the receiver when such devices are operated indoors.[17] This effect would occur throughout the United States as a result of desensitizing interference to the television set on any channel, and is irrespective of whether the unlicensed device has found an "empty" television channel. In other words, the average American family could not receive free, over-the-air television on any channel if a portable unlicensed device were operating within their home or, in many cases, a nearby home or apartment unit.

The CRC Study carefully evaluated the impact to both analog and digital television receivers of "personal/portable" unlicensed devices, such as Wi-Fi like cards in laptop computer or wireless in-home LANs, and determined that "there is a definite de-sensitization of the TV receiver caused by emission of the unlicensed device into the TV channel."[18] This de-sensitization is "significant" as to DTV receivers even as far away as 24 meters from the personal unlicensed device.[19] The data shows an even greater desensitization for NTSC sets. Specifically, CRC simulated a portable device signal at bandwidths of 0.43, 1.3, and 5.6 MHz to

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[17] MSTV/NAB Engineering Study at 10-14 (summary) and App. 1, Laboratory Evaluation of Unlicensed Devices Interference to NTSC and ATSC DTV Systems in the UHF Band ("CRC Study").

[18] MSTV/NAB Engineering Study at 11.

[19] *Id.* at 11-12.

represent the various bandwidths that may be encountered with actual portable devices.[20] The CRC Study measured the effect of these signals on both NTSC and DTV sets at distances varying from 3 to 24 meters. Although the results are generally proportional to the portable signal bandwidth and distance, in all cases significant desensitization of the NTSC or DTV receiver occurred. Further tests showed that the television receiver is susceptible to interference even if there is an intervening wall constructed of drywall plaster board with steel studs between the portable device and the receiver, as may be encountered in an office environment, hotel, or apartment.[21] CRC concludes that such harmful desensitization occurs because the portable emission limit under the Commission's Part 15 rules is much higher than the receiver equivalent noise floor for DTV and NTSC receivers.[22]

The CRC Study also shows that indoor unlicensed portable device operation will not only harm the public's ability to watch free, over-the-air television; it will also interfere with viewership of cable and satellite television.[23] CRC transmitted a 100 mW wideband signal through a Silver Sensor antenna with approximately -5dB gain and measured its effect on an RG-6 double-shielded cable and an RG-59 single-shielded cable. The results showed that even the double-shielded RG-6 cable will pick up interference from the portable device unless it is

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[20] *Id.* at 10.

[21] *Id.*

[22] *Id.* at 5. A related problem is the Notice's proposal to allow portable unlicensed devices within the television service contours of adjacent and taboo channels. Depending on the channel relationship between the unlicensed device and the television taboo channel, the unlicensed device could cause harmful interference within 138 meters of an analog television receiver or 25 meters of a digital television receiver. The interference potential is even more dramatic when an unlicensed device operates on an adjacent television channel. There, the unlicensed device could cause interference as far as 1550 meters from a digital television set or 439 meters for an analog television set. *Id.* at 8.

[23] *Id.* at 39-40.

terminated.[24] The RG-59 cable, which is often used by non-professionals to install an additional cable outlet in a residence, will experience significant ingress interference whether or not the cable is terminated.

In reaching the conclusion that unlicensed personal devices operating indoors will significantly interfere with analog and digital television sets, CRC employed objective, conservative methods. For example, the CRC Study adjusted the power of the noise-like signal which simulated the portable unlicensed device to be at least 3dB below the Commission's Part 15 rules of 200 μV/m (46 dBμV/m) within a 120 kHz bandwidth at 3 meters.[25] In its attached study, CRC has further documented the conservative and objective means by which it determined that indoor use of portable unlicensed devices would be incompatible with television viewing.

The effect of the proposed portable device operation on the public's television service should not be underestimated. Unsuspecting customers who purchase Wi-Fi and other portable unlicensed devices designed to operate in the home will find themselves unable to watch free, over-the-air television. A recent analysis conducted by NAB indicates that 18.9 percent of homes in the United States rely solely on over-the-air reception – this equates to over 20 million households with over 40 million people. In some markets, the number of homes not connected to cable or satellite services may reach as high as 40 percent. And variations occur along cultural lines as well. For example, Univision reports that nationwide, 33 percent of Hispanic households

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[24] Termination requires connection of a screw-on 75 ohm termination resistor at every cable outlet. It is thus common that the cable will not be terminated.

[25] *Id.* at 30, *citing* 47 C.F.R. § 15.209(a).

receive their television programming solely over the air.[26] In addition, among those households subscribing to cable or satellite television services, 20 percent have one or more television sets that are not connected to the pay service.[27] Overall, there are 73 million television sets in the United States that receive solely free, over-the-air television service.[28]

The impact of unlicensed devices on cable and satellite television service would also be severe. For example, based on the results of the CRC Study on ingress interference to cable, if a hotel guest in one room were operating a portable device that accurately found an "empty" television broadcast channel, a guest in a neighboring room may be unable to watch cable television. Consumers will experience similar problems in their own homes and apartments as well.

To echo an earlier point, interference from portable unlicensed devices would be particularly disruptive in the digital context. Word would spread that digital television sets are "inexplicably" unable to receive consistent over-the-air or even cable reception. An economic study prepared by John Haring and Jeffrey H. Rholfs of Strategic Policy Research documented to

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[26] Comments of Univision Communications Inc., MB Docket No. 04-210 at 8 (filed Aug. 11, 2004).

[27] Comments of NAB and MSTV, MB Docket No. 04-210 (filed Aug. 11, 2004); *see also* Comments of the Association of Public Television Stations in MB Docket No. 04-210, at 10 (filed Aug. 11, 2004) (estimating 34.5 million over-the-air sets in homes that also subscribe to cable or satellite); Comments of the Consumer Electronics Association, MB Docket No. 04-210, at 4 (filed Aug. 11, 2004) ("[E]ven in cable and/or satellite households, not every television in the household may be connected to these services. This reflects the household's conscious decision whether or not to connect."); Comments of Sinclair Broadcast Group, Inc., MB Docket No. 04-210, at 3 (filed Aug. 11, 2004) ("Approximately 33 percent of the respondents [to a survey conducted by Sinclair] live in households with at least one television that is used exclusively for free, over-the-air analog reception.).

[28] Comments of NAB and MSTV, MB Docket No. 04-210 (filed Aug. 11, 2004).

the Commission these "reverse bandwagon" economic effects of disruptions to DTV reception.[29] Such effects would, in turn, sharply undermine demand for digital television sets, substantially delaying and perhaps even making it impossible to reach the statutorily-mandated 85 percent threshold for concluding the transition in both rural and populous markets.[30]

Accordingly, the Commission should not proceed with the Notice's proposal to allow operation of portable devices in the television broadcast spectrum. Whether or not an unlicensed device can sense that a television channel is "vacant" – and the evidence suggests it cannot – portable unlicensed devices operating indoors would be incompatible with television viewing in the typical American home. As Commissioner Adelstein noted in his statement on the Notice, "Unlicensed operations should not be permitted in the television bands if they appear to be likely to cause harmful interference to TV reception … The American people care a lot about the quality of their television reception."[31]

B. Unlicensed Devices Are Not Able To Reliably Determine Whether A Television Channel Is Vacant.

In addition to the desensitization of NTSC and DTV television sets caused by portable unlicensed devices, television consumers would suffer interference from both fixed and

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[29] MSTV/NAB NOI Joint Comments, Attachment B, John Haring and Jeffrey H. Rohlfs of Strategic Policy Research, *Permitting Unlicensed Devices on Broadcast Spectrum during the DTV Transition: Substantial Costs and Risks, Largely Speculative Benefits*, at 14-15 ("Because consumers will initially have had little experience with off-air DTV, problems with off-air reception may affect their entire perception of the product and discourage widespread adoption … Smaller potential audiences obviously make investments in program and transmission equipment upgrades less attractive. Lower sales of digital sets and tuners slow the pace at which suppliers of such equipment 'move down the learning curve' and the ease with which they can realize economies of larger scale production. Bandwagon effects may operate, but the bandwagon may roll in the wrong direction.").

[30] *See* 47 U.S.C. § 309(j)(14)(B).

[31] Unlicensed Devices NPRM, Statement of Commissioner Jonathan S. Adelstein.

portable devices when those devices mistakenly identify a television channel as "vacant." As the Commission has recognized, an unlicensed overlay regime will fail the public's expectation for interference-free television reception unless it has "the ability to determine whether a TV channel or frequency band is unused before it could transmit."[32] The Notice proposes three methods which it claims would meet this requirement: 1) determination of an unlicensed device's location by a professional installer or use of geo-location technology such as GPS incorporated within the device, followed by a comparison of that location information with a database of protected service contours of licensed stations; 2) transmission of information concerning vacant television channels, if any, from an external "control signal" source such as a broadcast station or another unlicensed transmitter; 3) incorporation of sensing capabilities in the unlicensed device allowing it to detect whether other transmitters are operating in a given area.[33] As described below, these methods would not, in fact, produce a reliable prediction of whether a television channel is "vacant" and thus available for overlay use by an unlicensed device.

First, reliance on an existing, static database to identify television channels not in use would be impractical.[34] Especially during the digital transition, existing databases are not sufficiently timely or detailed to accurately identify precise geographic locations where unlicensed devices may operate without harming the public's reception of free, over-the-air television. The considerable time and resources, both on the part of licensees and the Commission, required to create a more accurate Table of Station Assignment and Service

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[32] Unlicensed Devices NPRM at ¶ 17.

[33] *Id.* at ¶ 20.

[34] MSTV and NAB understand that IEEE 802.18 will comment in further technical detail on the failings of the proposal to determine the presence of an available "white space" by comparing unlicensed device location information, derived by GPS or a professional installer's recording, with a static database of television station information.

Information highlight the problems with reliance on a static database when the information relied upon must be virtually without flaw.[35] Even if the database information were wholly correct, complete, and up-to-date, use of GPS technology to identify the unlicensed device's location would not be sufficiently reliable to prevent interference to an occupied television channel. GPS receivers cannot function under many circumstances, including indoor locations and those "shadowed" by tall buildings, mountains, or other structures. This is a fatal limitation.

Use of a "control signal" to determine whether an unlicensed device can safely operate on an "unoccupied" television channel would be similarly unsuccessful. Theoretically, the unlicensed device would "listen" for a control signal emanating from another unlicensed device or a fixed transmitter to determine whether, in the device's location, it could safely operate on the frequency for a given television channel. In practice, the unlicensed device may not "hear" the correct signal. Many unlicensed devices will suffer from the hidden node problem, whereby the base station has a good line of sight to the unlicensed device but not the television transmitter. As a result, the unlicensed device will receive permission from the base station to operate on a given channel which is, in fact, used to deliver television services to the public. Similarly, an unlicensed device may receive conflicting control signals from adjacent television markets and be unable to comprehend both. For example, an unlicensed device in Springfield, Virginia could receive a control signal northwest of Washington, D.C. indicating that a particular channel is "unoccupied," while, because of a shadowing effect, it was unable to receive the correct control signal located southeast of Washington, indicating that the same channel is

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[35] *Second Periodic Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television*, Report and Order, FCC 04-192, MB Docket No. 03-15, at ¶ 36 (rel. Sept. 7, 2004) (Announcing that the Media Bureau will issue a preliminary Table of Station Assignment and Service Information but advising licensees to review the Table and submit corrections to the Commission prior to making mandatory pre-election certifications).

already in use in Goldvein, Virginia. Because use of a control signal cannot prevent unlicensed devices from operating on occupied television channels, the Commission should not rely on that method to preserve the public's access to free, over-the-air television.

Finally, the Notice's proposal to rely on cognitive radio technology to prevent unlicensed devices from operating on occupied television channels is premised on technology that has not yet been sufficiently developed or tested. Indeed, the Commission has before it a *pending* NPRM to "facilitate the development" of cognitive radio technologies.[36] It was only earlier this month that the Commission approved the *first-ever* software defined radio device in the United States.[37] While such technology may hold promise, the Commission cannot risk the health of the public's broadcast television service today on the basis of technology that may or may not be developed tomorrow.

C. The Notice's Proposal Does Not Provide A Feasible Mechanism For Enforcement Against Harmful Interference From Unlicensed Devices.

Compounding the serious flaws described above, once the unlicensed devices are in the field, broadcasters and the Commission would have no reliable means of protecting the public's television service from harmful interference. Although as a legal matter the Commission's Part 15 rules would privilege the licensed broadcast uses over the unlicensed transmissions in an interference dispute, as a practical matter this precedence would be of little value. Reliance on the Notice's proposed enforcement mechanisms will not protect the public's access to free, over-the-air television.

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[36] *Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies*, 18 FCC Rcd 26859, Separate Statement of Commission Kevin J. Martin (2003).

[37] *FCC Approves First Software Defined Radio*, Public Notice, Nov. 19, 2004.

Rarely will broadcasters, the Commission, or the public even be aware of harmful interference from unlicensed devices, because most cases of interference from unlicensed devices will go unreported. If unable to receive a station's signal, viewers may simply assume that the interference is caused by a problem with the broadcaster's transmission or their sets. They are more likely to change the channel than they are to call the broadcaster. It may thus take years before anything approaching the full impact of interfering unlicensed devices on the public's access to free, over-the-air television would come to light.

Even when interference is reported and linked to unlicensed devices, the Commission would not typically be able to find and shut down the interfering devices.[38] Just as control signal technology or GPS tracking of unlicensed devices could not reliably *prevent* interference, these technological approaches should not be expected to *police* it.[39] Attempts to use traditional means to remedy harmful interference from unlicensed devices (*i.e.*, finding the offending transmitter and ordering it to cease operation) would sap both Commission and broadcaster resources, especially as the number of devices out in the field proliferates.[40] MSTV and NAB agree with Sprint's comment that "once interfering unlicensed devices are in the

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[38] *See, e.g.*, *High-Tech Companies Defend FCC's Part 15 Regulatory Scheme*, FCC Report, June 14, 2002 (citing experience of amateur radio systems, which share spectrum with Wi-Fi devices, that the obligation of unlicensed devices to cease operation if they cause harmful interference to licensed operations "is an allusion.").

[39] SPTF Report, at 58 ("[O]nce unlicensed devices begin to operate . . . it may be difficult legally or politically to shut down their operations even if they begin to cause interference or otherwise limit the licensed user's flexibility."); *Review of Part 15 and Other Parts of the Commission's Rules*, 17 FCC Rcd 14063, 14067 (2002) (describing interference caused by unlicensed radar detectors to VSATs in the 11.7-12.2 GHz band, and noting that the radar detectors could not easily be identified or, even if identified, controlled).

[40] *See, e.g.*, Unlicensed Devices NPRM, Statement of Commissioner Michael J. Copps ("I want to encourage the Bureau and my colleagues to be vigilant to ensure that we have the investigative and enforcement resources and plans in place as we pursue more and more complicated spectrum arrangements.").

market, it will … potentially be virtually impossible for the Commission to recall these devices."[41]

Some unlicensed devices may create emissions which are just below the level of "harmful" interference subject to enforcement under the Commission's Part 15 rules. The cumulative effect of these devices crowding the broadcast spectrum will be to raise the noise floor, gradually but significantly degrading the quality of the public's free and universal television service. The signal quality in the AM radio broadcast spectrum similarly deteriorated as the Commission relaxed interference rules to accommodate short-term policy objectives. While AM stations continue to provide a vital and popular service, failure to protect the AM band from cumulative interference has reduced the value of the band to licensees and impaired the service enjoyed by AM radio listeners.[42] Just as the AM incumbents were unable to identify a single source of that harmful interference, broadcasters may not be able to point to a particular unlicensed device as warranting enforcement action. The threat here is worse than in the AM context, because the sources of interference are likely to number in hundreds or even the thousands, just in a single market. Enforcement mechanisms will not be sufficient to prevent the "AM-ization" of the public's over-the-air television service if the Commission goes forward with its unlicensed devices proposal.

III. DURING THE DIGITAL TRANSITION, THERE IS LITTLE OR NO "WHITE SPACE" SPECTRUM AVAILABLE OUTSIDE OF UNPOPULATED AREAS.

Because there is a lack of "white space" spectrum available for use by unlicensed devices during the digital transition, the primary public interest benefit of the Notice's proposal –

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[41] Sprint Reply Comments, ET Docket No. 02-380, at 2 (filed May 22, 2003).

[42] Joint Comments of MSTV and NAB, ET Docket No. 02-135 at 8 (filed Jan. 27, 2003).

making spectrum available to new uses – is moot.[43] The attached engineering study,[44] based on tests conducted by TechWare, Inc. (TechWare Study) for MSTV, disproves the notion that there is available "white space" spectrum throughout the U.S. prior to the conclusion of the transition to digital television.[45] Also, it would be extraordinarily difficult to identify where any "white areas" would be located while the Commission is just beginning the complicated channel election and repacking process by which stations will receive their final DTV allotments. Another open question is the digital allotments for thousands of Class A, LPTV, translator, and booster stations. Consumers purchasing devices purportedly designed to operate in "white space" would thus be disappointed when a television broadcast signal later allocated to the same space prevents that device from operating properly.

Employing conservative assumptions to account for technical ambiguities and uncertainties in the Notice's proposal, the TechWare Study showed that while some television channels are available for unlicensed fixed operation in certain rural areas, few or no channels are available in major metropolitan areas throughout the United States. (And the particular sensitivity of rooftop television antennas used in rural areas increases the potential for unlicensed device interference there, thus decreasing the availability of "white space" spectrum even in

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[43] Unlicensed Devices NPRM at ¶ 1 (describing a belief that allowing unlicensed access to the television broadcast frequencies would have "significant benefits for the public by allowing the development of new and innovative types of unlicensed broadband devices and services for businesses and consumers.").

[44] MSTV/NAB Engineering Study at 14-21.

[45] Unlicensed Devices NPRM at ¶ 13 ("[D]uring and after the DTV transition there will typically be a number of TV channels in a given geographic area that are not being used by full service analog or digital TV stations.").

sparsely populated parts of the country.[46]) Employing the proposed protection ratios and service contours identified in the Commission's Notice, the study used a software model which simulated a network of unlicensed devices superimposed in different geographic regions within the U.S.[47] The results plainly showed that little or no television "white space" spectrum exists outside of less populated and rural areas of the country. For example, Figure 6 of the Engineering Study is a map depicting the availability of unlicensed device channels in the Northeast region of the U.S. From southern New Hampshire to Richmond, Virginia, it is nearly impossible to find an area sufficiently large to permit operation of an unlicensed device network in the television broadcast spectrum. And as the map also shows, where there may be "white areas," the availability of spectrum varies significantly from one small geographical cell to the next.

Creating a reliable map of "white space" spectrum is further complicated by uncertainty concerning the ultimate broadcast uses of the spectrum. To start the transition, and in recognition of the need to maintain the public's analog television service while the transition to digital television was proceeding, the Commission doubled the number of television station

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[46] In sparsely populated rural areas, many viewers are located beyond a station's Grade B signal, and certainly beyond the Grade A contour of LPTV and translator stations. Accordingly, these viewers rely on pre-amped, high-gain antennas to receive the weaker signals from translators or distant broadcast stations. Rural viewers are thus highly susceptible to interference not only from portable unlicensed devices, but base stations as well. For example, in the weak signal conditions common in many rural areas, spectrum sensing equipment may determine that a channel is "vacant" at a particular location. However, by using roof top pre-amped antennas, consumers in that same location will rely on an extremely weak broadcast signal on the same channel for local television service. The net result is harmful interference which denies rural Americans access to free, over-the-air television service. Of course, weak signal conditions also make television receivers more susceptible to interference from portable unlicensed devices.

[47] Also, the study assumed a 4.0 watt ERP transmitter with an omni-directional antenna placed at each intersection of a 30-second grid (latitude and longitude) across the major populated areas of the U.S. The transmitter height was set at a modest height of 30 meters HAAT. *See* MSTV/NAB Engineering Study at 14.

operations in the existing band. However, it maintained the existing frequency band, squeezing 1600 digital television stations in between the existing 1600 analog stations. Broadcast spectrum is thus congested. As Commissioner Martin commented in his partial dissent to the unlicensed devices NOI,

> As part of the digital transition, we have dramatically increased the number of broadcast licenses in the broadcast bands. Particularly in urban areas, such as along the east and west coasts, there is much less broadcast spectrum available within which unlicensed devices could operate effectively.[48]

To illustrate the complicated channel election and repacking situation facing the television broadcast band in major metropolitan markets, MSTV has attached as Exhibit B a chart depicting the adjacent television markets in New York City and Philadelphia during the digital transition. For the channel election process to work for the 43 full-power television stations in those markets, the Commission will likely have to resolve numerous conflicts and potential interference scenarios. Simply finding space for full-power television stations during the digital transition is complicated enough; adding unlicensed devices to that mix would needlessly complicate and destabilize an already challenging task.

Further congesting the television broadcast band is the Commission's and Congress's determination – based on the spectral efficiency of digital technology – to condense the television broadcast band from its current plan (channels 2-69) to a final "in-core" band (channels 2-51). Although this decision will open up channels 52-69 to important public safety and may enable innovative licensed commercial uses, prior to the conclusion of the digital transition it means an even more crowded in-core band. Specifically, before broadcasters are

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[48] Unlicensed Devices NOI, Separate Statement of Commissioner Kevin J. Martin.

able to vacate the analog spectrum, the Commission must fit in to the in-core band nearly 100 stations that have both analog and digital out-of-core assignments.

Moreover, the broadcast industry is currently faced with a crisis over the availability of spectrum to provide live remote coverage of news and sporting events. As MSTV has noted on previous occasions, broadcasters depend heavily on wireless microphones and cameras to provide live coverage of major events.[49] These wireless devices currently use the "vacant channels" in the UHF band to operate. Yet with the advent of digital television these channels are used heavily, making it difficult in major markets to find sufficient spectrum for the proper operation of wireless microphones. As a result, broadcasters are already experiencing significant obstacles to covering events of local and national importance. Yet the Notice's proposal would put wireless microphones in conflict with unlicensed devices for scarce spectrum. Thus, operation of unlicensed devices in the broadcast band would seriously undermine a broadcaster's ability to use existing wireless production devices and provide remote coverage of important events.

In light of the above, it would be unfair to consumers to allow unlicensed devices to operate in the television broadcast spectrum. With the Commission's channel election and repacking plan ongoing through at least 2006, many frequencies that currently appear "vacant" will become occupied.[50] An even greater unknown is the future spectral locations of thousands

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[49] *See, e.g.*, Letter from David L. Donovan, President, MSTV, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 02-380 (filed June 23, 2003) (attaching transcript of video demonstrating concerns with the availability of spectrum for wireless microphones).

[50] *Second Periodic Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television*, Report and Order, MB Docket No. 03-15, FCC 04-192, at ¶ 65 (rel. Sept. 7, 2004.

of Class A and other stations.[51] As a result, consumers purchasing devices designed to operate on currently "vacant" channels will be unable to use those devices after the conclusion of the digital transition. The effect will be similar to that recently reported in the 380-400 MHz band, in which the government deployed a new licensed land-based mobile system on spectrum shared with unlicensed uses. Once the more powerful licensed system was activated, garage door openers working on the same frequencies throughout a 10-15 mile radius stopped working. The practical effect of this conflict was not lost on residents – "kids would come home from school and couldn't get in the house because they suddenly couldn't open their garage doors."[52] Plainly, it is only after the digital transition that there may be opportunities for new uses of the broadcast television spectrum.

IV. IF THE COMMISSION CHOOSES TO PROCEED WITH NEW SHARED USES OF THE BROADCAST TELEVISION SPECTRUM, IT MUST SPECIFY, TEST, AND SOLICIT PUBLIC COMMENT ON PARAMETERS INTENDED TO PROTECT THE PUBLIC'S FREE, OVER-THE-AIR TELEVISION SERVICE.

The attached studies showing the interference potential of unlicensed devices operating in the television broadcast band and the lack of available "white space" spectrum during the digital transition overwhelmingly discredit the assumptions on which the Notice has premised its unlicensed devices proposal. Accordingly, if the Commission desires to open the television broadcast spectrum to new shared uses, it must design, articulate, test, and solicit public comment on a new proposal.

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[51] Congress has also committed to adding 175 new full-power digital allotments after the transition. *See* Community Broadcasters Protection Act of 1999, Pub. L. No. 106-113, § 1000(a)(9), 113 Stat. 1536 (1999).

[52] *AWS Shows Reallocation Still Too Slow, Thomas Says*, Communications Daily, Nov. 1, 2004 (citing statements by OET Chief Edmund Thomas).

An overarching concern with the Commission's current plan is its use of broad and undefined standards for operation of unlicensed devices. Attempting to address this concern, MSTV sought clarification of the Notice to allow the public to produce a "full and responsive assessment of issues raised by [the] proposal."[53] For example, MSTV asked for identification of the "other appropriate models" besides the broadcast F(50,50) curves which the NPRM would allow manufacturers to use in calculating undesired signal levels of unlicensed devices.[54] As MSTV explained, clarification would "eliminate confusion among the various commenters about which model parties have used in reaching their conclusions about the Commission's proposal."[55] In a July 27, 2004 response to MSTV, Office of Engineering and Technology (OET) Chief Edmund Thomas affirmed the Commission's decision to provide "flexibility" in the means by which interference potential may be calculated, writing that "it should be clear from the *Notice* that the Commission did not propose a specific propagation model for determining the level of undesired signals."[56] In light of the importance of the broadcast television service, the proliferation of tens of millions of television receivers in which the public has invested billions of dollars, and the vulnerability of this service to interference, MSTV and NAB disagree with this approach. Before proceeding with any proposal, the Commission should specifically articulate the parameters of new operations that would be authorized to use the same spectrum as the public's television service.

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[53] Request for Clarification of MSTV, ET Docket No. 04-186, at 1 (filed June 21, 2004).

[54] *Id.* at 7.

[55] *Id.*

[56] Letter from Edmond Thomas, Chief, OET, FCC, to David Donovan, President, MSTV, July 27, 2004 at 5. MSTV has asked that the FCC include this letter as part of the record in ET Dockets Nos. 02-380 and 04-186.

The Commission should also conduct and report on comprehensive studies testing the interference potential of unlicensed device operation in the broadcast television spectrum. It is not enough to map out a theoretical interference analysis on paper. Just as theoretical interference models did not predict the interference between CMRS and public safety communications systems in the 800 MHz band,[57] they cannot reliably predict whether unlicensed devices would harm broadcast television reception. Simply put, the American public's television service "is not to be trifled with."[58] The Commission should not introduce new uses of the television broadcast spectrum without actual proof – in the form of detailed engineering studies – that such uses will preserve access to free, over-the-air television while producing other new, public interest benefits. And such proof cannot even be adduced until those uses are defined with specificity.

V. THE COMMISSION ALSO SHOULD RE-EVALUATE THE EFFECT OF ITS PROPOSAL ON OTHER STAKEHOLDERS OF LICENSED SPECTRUM.

A. The Notice's Proposal Fails To Consider The Relative Benefits Of *Licensed* "White Space" Use, Especially In The Enforcement Arena.

As it reconsiders its proposal, the Commission should give serious consideration to the (post-DTV transition) benefits of *licensed* "white space" usage. As expressed by the Spectrum Policy Task Force, there is a general and well founded concern about having an unlicensed regime share the same spectrum as the licensed uses.[59] This concern is particularly

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[57] *Improving Public Safety Communications in the 800 MHz Band*, 19 FCC Rcd 14969, at ¶ 13 (2004) ("Despite the claims by some that licensees in the cellular telephone bands cause little interference to 800 MHz band public safety systems, strong evidence exists to the contrary.").

[58] Unlicensed Devices NPRM, Statement of Commissioner Jonathan S. Adelstein.

[59] SPTF Report at 55 (explaining that as the Commission considers overlay spectrum models, it "must take into account the need for licensed spectrum users to have flexible and clearly-defined spectrum usage rights that promote efficient and beneficial spectrum use.").

acute in the broadcast context, which the SPTF Report advised "should remain subject to the current regulatory model, which is based on statutory public interest objectives."[60] An unlicensed interleaved overlay regime is complicated and may not work in conjunction with the fluid and vulnerable broadcast uses, especially in light of the high-power and widely-proliferating uses envisioned by the Notice. On the other hand, a licensed overlay option would allow the market to make efficient use of any "white space" spectrum in the television broadcast band while mitigating many of the interference concerns which arise from sharing spectrum on which the public's television service is delivered.

If any "white spaces" in the television broadcast band were assigned by auction, the designated licensees would have incentive to invest in equipment which would minimize the creation of "noise" and other interference in that spectrum. Just as a homeowner does not wish to pollute his or her own immediate neighborhood, a "white space" licensee would not wish to see the noise floor of that spectrum rise to harmful levels. This is in contrast to unlicensed spectrum manufacturers, who do not have an economic incentive to minimize interference to other devices, let alone to the public receiving broadcast service, within a particular "white space."[61] Experience in the unlicensed 2.4 GHz band is instructive. There, cordless phones have "reap[ed] devastating effects on 802.11b WLANs" because the technologies used are not compatible for minimization of interference.[62] In licensed "white space," the same entity would

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[60] *Id.* at 6.

[61] *See, e.g.*, Amy Schatz, *U.S. Airports and Airlines Clash Over Radio Waves in Terminals*, The Asian Wall Street Journal, M8 (June 9, 2004) ("[A]s the source of [Wi-Fi] signals proliferate, they have triggered a turf war pitting airports against air carriers.").

[62] *Interference from Cordless Phones*, Wi-Fi Planet, April 15, 2003, *available at* http://www.wi-fiplanet.com/tutorials/article.php/2191241 (last visited Nov. 21, 2004).

control the spectrum used by both types of devices and would design all devices to operate on non-interfering technology.

Moreover, if a device operating on licensed "white space" were to interfere with the public's access to free, over-the-air television, the licensee responsible for the spectrum used by that device could be identified and made accountable for remedying the problem. By way of analogy, the difference between the two regulatory options is whether the public's television service will live next door to a busy public park or simply another home. It is much easier to ask persons in the latter to make less noise than it is the former. Although the Commission would still have to conduct detailed interference studies before allowing licensed overlays in the television broadcast spectrum, it is at least plausible that a working enforcement mechanism could be designed to remedy resulting interference to the public's television service. Such is not the case under the unlicensed devices proposal.

B. Adoption Of The Unlicensed Devices Proposal Would Undercut Congressional Expectations For Auction Revenue Of Licensed Spectrum.

Congress has long expressed an expectation that the long-delayed auction of the remaining 700 MHz spectrum designated for commercial use would produce substantial revenues for the U.S. Treasury.[63] To date, the Commission has auctioned only 24 MHz of the 84 MHz of 700 MHz commercial spectrum, leaving another 60 MHz that the Commission has indicated will likely be auctioned at or near completion of the digital transition and pending

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[63] H.R. Rep. 105-217, at 578 (1997) ("[New section 309(j)(14)(C) of the Communications Act] requires the Commission to assign by means of competitive bidding the 78 MHz that is reclaimed from incumbent broadcast licensees."); *Reallocation and Service Rules for the 698-746 MHz Spectrum Band (Television Channels 52-69)*, 16 FCC Rcd. 7278, 7280 (2001) ("Section 309(j)(14) of the Communications Act ... requires the Commission to assign spectrum recaptured from broadcast television as a result of the transition from analog to digital transmissions systems by competitive bidding.").

Advanced Wireless Services (AWS) proceedings.[64] Allowing unlicensed use of adjacent spectrum in the ch. 2-51 television spectrum could negatively impact the value of that spectrum at auction.[65]

By setting a precedent whereby the technical integrity of licensed spectrum is degraded, potential bidders of the 700 MHz spectrum (and all future licensed spectrum) will place a lower value on licensed spectrum. MSTV and NAB therefore agree with Qualcomm's concern that "permitting unlicensed devices to operate in the TV bands … may discourage parties from bidding for licenses in Commission auctions."[66] Those licensed broadband providers which participated in the initial 700 MHz auctions will be particularly hesitant to participate in the future 700 MHz auctions when their competitors have received access to adjacent spectrum without cost and with only scant accountability for interference they may cause to American television viewers.[67]

As explained earlier, the introduction of unlicensed devices into the public's television broadcast spectrum would stunt the digital transition. Naturally, this effect would also delay the auction of remaining 700 MHz commercial spectrum. Congress has already ordered the Commission to postpone the auction of 700 MHz spectrum once, at least partially in recognition that the spectrum is of lesser value to new uses while the public still relies on it for

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[64] *Auction Reform Act of 2002, Report to Congress*, 18 FCC Rcd 12556, 12557 (2003).

[65] Congress is currently considering using revenues from the 700 MHz spectrum auctions to help fund consumers' transition to digital television by subsidizing their purchase of set-top converters.

[66] Letter from Dean R. Bremmer, Senior Director, Government Affairs, Qualcomm, to Marlene H. Dortch, Secretary, FCC, ET Docket Nos. 04-186 and 02-380 (filed Sept. 28, 2004).

[67] For example, in auction of the upper 700 MHz guard band spectrum, Nextel spent nearly $346 million. *700 MHz Guard Band Closes*, Public Notice, DA 00-2154 (Sept. 25, 2000).

broadcast services.[68] Congress is unlikely to sympathize with the Commission if the Notice's proposal forces further delay in receipt of significant auction revenue by the U.S. Treasury.

VI. ADOPTION OF THE NOTICE'S PROPOSAL WOULD VIOLATE PRINCIPLES OF ADMINISTRATIVE PROCEDURE.

As discussed above, the proposed rules would allow for a myriad of uses not specifically articulated in the Notice. This absence of detail would violate sound principles of administrative law. Even if the Commission tests for and adopts rules protecting against harmful interference from the one or two sets of uses that the Notice did identify, it will not have done the same for other future uses, which will nevertheless be allowed under the loosely-defined rules.

The Notice does not comply with the Administrative Procedure Act (APA), which requires the Commission to publish an NPRM containing the "terms or substance of the proposed rule" and an opportunity for comments on that rule.[69] Under longstanding precedent, if a final rule does not "adequately frame the subjects for discussion," it is subject to vacatur.[70] MSTV has documented the lack of technical specificity in the Notice, including minimum/maximum operating bandwidth or channelization for the proposed unlicensed devices, modulation type, and method of calculating desired signal levels.[71] Most notable is the Notice's aforementioned proposal to allow calculation of undesired signal levels using "other appropriate models." The response from the Office of Engineering and Technology to MSTV's Request for Clarification did not alleviate the Notice's ambiguity. As a result, whatever final rule results

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[68] *See* Section 309(j)(15)(A) of the Communications Act, 47 U.S.C. § 309(j)(15)(A), as added by Section 3 of the Auction Reform Act of 2002, Pub. L. No. 107-195, 116 Stat. 715 (2002).

[69] 5 U.S.C. § 553(b)(3), (c).

[70] *Connecticut Light and Power Co. v. Nuclear Regulatory Comm'n*, 673 F.2d 525, 533 (D.C. Cir. 1982).

[71] *See* Request for Clarification of MSTV.

from the Notice is unlikely to constitute a "logical outgrowth" of the Notice's proposal.[72] In keeping with principles of sound administrative procedure, the Commission should not act on the Notice's proposals until it has provided adequate notice to the public of any and all new shared uses proposed for the television broadcast bands.

[72] *See Nat'l Black Media Coalition v. FCC*, 791 F.2d 1016 (2nd Cir. 1986).

CONCLUSION

For the reasons explained above, the Commission should not introduce any new shared uses into the television broadcast spectrum until after the conclusion of the transition to digital television, and in any event should revisit its proposal by articulating, carefully testing, and soliciting public comment concerning the operating parameters of such new uses. Otherwise, the American public will lose reliable access to the free and universal over-the-air television service.

Respectfully submitted,

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November 30, 2004

EXHIBIT A

Interference from the Operation of Unlicensed Devices in the Broadcast TV Bands

Engineering Study

(Docket 4-186)

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November 2004

Table of Contents

1. Introduction

The Commission has proposed to amend its rules to allow unlicensed devices to operate in the broadcast television spectrum at locations where the spectrum is "unused" by television stations.[1] Although the Commission's proposal implies that potential interference to the public's television service can be managed, there is serious concern for the theoretical and practical aspect of the Commission's proposal. The proposal does provide some specifics on power limitations for the unlicensed devices but falls short on technical details which would permit a full assessment of interference mechanisms and levels of impact to broadcast television. This engineering study attempts to mitigate the lack of information available in the proposal by addressing more general spectrum and interference issues. There may, however, be subtle mechanisms specific to spectrum masks, modulation techniques, network management strategies, device locations, and other factors that would render significant interference to broadcast television.[2]

The NPRM proposes several mechanisms intended to prevent interference. However, these mechanisms are deemed ineffective in controlling interference. For example, the Commission proposed that a fixed unlicensed device would either use a GPS receiver or have a "professional" installer determine its location relative to the surrounding TV stations using a public or private database. The use of GPS may be problematic if installations are made indoors or in shadowed areas where the satellite signals cannot be reliably received. In either case, a database of occupied TV channels must be provided to the fixed unlicensed device. The database of occupied TV channels may also be problematic since it needs to be accurate and must be updated frequently, if not continuously. This is

[1] *Unlicensed Operation in the TV Broadcast Bands*, Notice of Proposed Rulemaking, ET Docket No. 04-186, FCC 04-113 (released May 25, 2004) (hereinafter "*NPRM*").

[2] Attempting to address these concerns, MSTV filed a Request for Clarification on June 21, 2004. A response to the Request for Clarification was received on July 27, 2004 offered little guidance to clarify these concerns.

especially true during the roll out of the digital TV and the transition to an all digital service, and the possible implementation of new enhancements such as on-channel DTV repeater systems, distributed transmission systems and Enhanced VSB.

The NPRM proposes that portable unlicensed devices monitor a "positive" control signal from a fixed unlicensed transmitter to ascertain which TV channels are vacant. It is possible for the portable unlicensed device to receive a control signal from outside of the operating contour of a fixed transmitter and thus cause interference in a neighboring contour. Since the propagation characteristics between the fixed and portable unlicensed devices are indeterminate, there may be significant discrepancies in signal conditions between the fixed and portable unlicensed devices. This problem may prevent positive control of an unlicensed device network and lead to hidden nodes. Propagation uncertainties at the TV receiver, especially in the case of indoor reception, would lead to incorrect assumptions of the signal conditions at the TV receiver. Signal measurements at the fixed unlicensed devices may not reflect the signal conditions at the TV receiver.

The management of spectrum in the TV broadcast bands would no longer be viable. Since the devices are unlicensed, there is no way for broadcasters and other licensed users of the TV bands to establish ownership of a source of interference. The NPRM does require devices to periodically and automatically transmit a unique identification signal. The uniqueness of the signal, however, is not clear. Unless each unlicensed device has its own unique identification signal, the source of interference could not be identified. If unlicensed devices are part of a network, it is likely that the unlicensed device would be operating intermittently. Even with an identification signal, the lack of licensing makes it difficult, if not impossible, to physically locate the device and identify ownership. The problem is compounded since the TV receiver locations are also indeterminate. It is unlikely that an

installer of an unlicensed device could know with precision, the location of TV receivers within the service area of the unlicensed device.

In order to better understand the impact of unlicensed devices on broadcast television service, MSTV commissioned two studies. The first study focused on a laboratory evaluation of interference to both analog and digital broadcast television caused by a portable unlicensed device operating in a close vicinity of television receivers or other licensed devices in this band. The second focused on the availability of so called "vacant channels" for unlicensed fixed/access operation in a number of regions within the continental United States.

The NPRM proposes that the unlicensed device be allowed to operate in a broadcast channel provided that the emissions into other broadcast channels complies with §15.209(a)[3]. §15.209 requires that the field strength in the UHF band at 3 meters must not exceed 200 µV/m (or 46 dBµV/m) within a 120 kHz bandwidth. This interference when transferred from a half-wave dipole to a matched impedance receiver input would provide an input power to the receiver of between –82.6 dBm (on channel 14) and –85.9 dBm (on channel 51) within a 120 kHz bandwidth. The power levels from a directional receive antenna may be higher. These power levels are of concern. If the emission from the unlicensed device is broadband and occupies 5.6 MHz of the 6 MHz TV channel, the total interference power in the channel will be 16.7 dB higher (-65.9 dBm at channel 14 and –69.2 dBm at channel 51). The emissions from a nearby unlicensed device could cause the AGC circuit in the TV receiver to reduce its tuner gain, and thus, de-sensitize the receiver and impair its reception of weak TV signals. The ATSC Recommended Practice for Receiver Performance Guidelines recommends a DTV receiver sensitivity of –83 dBm

[3] 47 C.F.R. § 15.209 (a)

(measured over 6 MHz without noise or multipath)[4]. Since a DTV receiver typically requires a 15 dB S/N, the noise floor of the receiver is –98 dBm. The proposed level of interference is significantly higher than the noise floor of a typical DTV receiver.[5]

The establishment of DTV service in the Sixth NPRM[6] and calculation of service areas in the OET Bulletin 69[7], involve a series of planning factors used to delineate the limits of a DTV service area. These planning factors imply that the DTV receiver will be operating at the limit of its sensitivity of –84.2 dBm (based on the thermal noise floor, required S/N, and Noise Figure of the receiver). In addition, the calculation of service area implies that the DTV receiver will be protected to the limit of its sensitivity. This protection from interference is further emphasized in the Reconsideration of the Sixth Report and Order[8]. The RF emission mask for DTV transmitters was tightened to explicitly address adjacent channel interference concerns. Since no allowance has been made for additional interference within the broadcast television band, there is great concern that unlicensed devices will adversely impact the performance of the TV receiver.

The Commission proposes the use of these portable unlicensed devices within the television service contours of adjacent and taboos channels. Specifically, the NPRM asserts that at a distance less than 10 meters from a TV receiver, unlicensed devices will be under the control of the operator and if they cause interference they could be turned off. The NPRM goes on to infer that beyond 10 meters interference will not be an issue. The

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[4] ATSC Recommended Practice: Receiver Performance Guidelines, Advanced Television Systems Committee Document A/74, p. 11, 18 June 2004.
[5] Similar results were derived for an NTSC receiver.
[6] Sixth Further Notice of Proposed Rule Making, MM Docket No. 87-268, "Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service," Released: August 14, 1996.
[7] Longley-Rice Methodology for Evaluating TV Coverage and Interference, OET Bulletin No. 69, July 2, 1997.
[8] Memorandum Opinion and Order on Reconsideration of the Sixth Report and Order. MM Docket No. 87-268, "Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service, Paragraph 91, Released: February 23, 1998.

Commission is incorrect on both issues. First, it is unrealistic to assume that the operator will control the interference within 10 meters of a TV receiver since in many urban settings such as apartments, condominiums, office buildings, and suburban homes, a television receiver located 10 meters away from an unlicensed radiator may likely be in an adjacent dwelling. Second, portable operation within the TV service contours of adjacent and taboos channels *will* cause interference to TV receivers at distances beyond 10 meters. Depending on the channel relationship between the unlicensed device and the TV taboo channel, the unlicensed device could cause interference to a TV receiver as far as 138 meters away for NTSC and 25 meters for DTV. Moreover, operating on an adjacent channel could cause interference as far as 1550 meters for DTV and 439 for NTSC.[9] Unfortunately, the Proposal did not take into account the potential for interference from the operation of these devices on taboo channels.

The NPRM proposes the same NTSC-to-DTV and DTV-to-DTV co-channel and adjacent channel interference protection rules (D/U ratios) to allow unlicensed transmitters to operate in the TV bands. The applicability of these TV protection rules for an unlicensed device service is inappropriate. Unlike television transmitters, unlicensed fixed transmitters could be placed anywhere, including within the TV service area of an adjacent channel. NTSC transmitters on the other hand can not be located within the adjacent TV service areas, they must be at least 55 miles- away, while DTV transmitters operating on adjacent channels where intentionally co-located or near co-located as a means of

[9] Using the DTV-to-NTSC D/U ratios in Bulletin OET-69, the following separation distances were computed using a maximum 400 mill watts ERP for the unlicensed transmitter and a free space propagation model: For N+8, 55 meters; N-7, 39 meters; N-4, 44 meters; N-3, 69 meters; N-2, 138 meters; N+2, 87 meters; N+3, 44 meters; N+4, 123 meters; N+7, 16; N+8, 16 meters; N+8, 16 meters; N+14, 49 meters, N+15, 62 meters; N-1, 309 meters; N+1, 437. Using the ATSC A-74 Recommended Practice DTV-to-DTV ratios for taboos, the following separation distances were also computed: For N+1, 1550 meters; N-1, 1231 meters; N+1, 1550 meters; N-2, 25 meters; N-3, 16 meters; N+(6-14), 14 meters; N+15, 13 meters.

controlling propagation characteristics so that proper Desired-to-Undesired (D/U) levels are maintained independent of the DTV receiver location. The propagation path and characteristics for the desired TV channel will be very different from the interfering unlicensed device. These characteristics are sure to vary greatly over a given service area.

The purpose of the laboratory study is to assess the impact that the out-of-channel emission from an unlicensed device would have on a broadcast receiver. Specifically, the laboratory tests consider the potential for de-sensitization of the TV receiver by the unlicensed device at various separation distances through obstructions, such a wall.

The second study is an analysis of potential sites for unlicensed device operation based upon the proposed Commission's rules for co-channel and adjacent channel interference D/U ratios. Specifically, the study looks at the number of available or "vacant" TV channels that could be utilized for unlicensed transmitters in major urban regions of the United States.

2. Laboratory Evaluation of Interference from Unlicensed Devices in the Broadcast TV Band

The goal of the laboratory evaluation is to objectively measure the potential for interference to broadcast TV from unlicensed devices out of band emission. The Communications Research Centre Canada (CRC) performed the tests. The test bed illustrated in Figure 1 was used to create the interference scenario. A broadcast signal is transmitted on either a low UHF channel for NTSC and a high UHF channel for DTV. The laboratory study includes a simulated "unlicensed device" with a "noise-like" emission in the broadcast television channel. The power of the unlicensed device emission is conservatively adjusted so that the power into the broadcast channel is at least 3 dB below

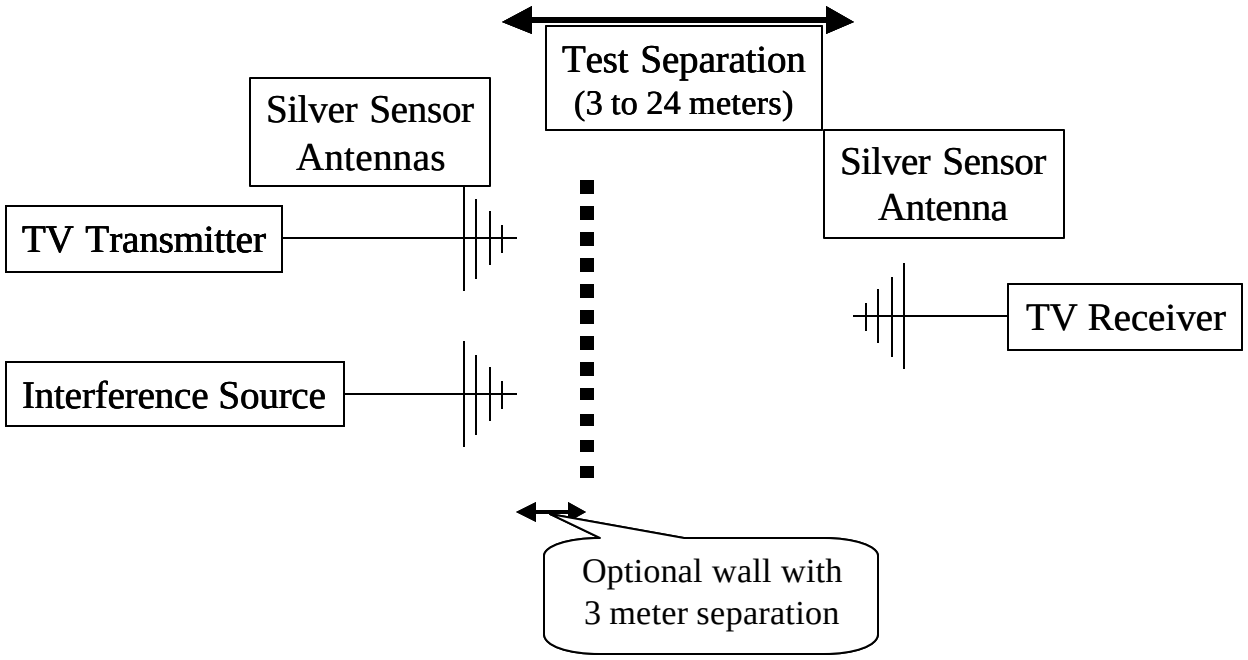


Figure 1 – Laboratory test setup used to evaluate TV receiver de-sensitization resulting from the emission of an "unlicensed device" into the TV channel.

the FCC rule[10] of 200 µV/m (46 dBµV/m) within a 120 kHz bandwidth at 3 meters. The test used a "noise-like" signal with various bandwidths of 0.43, 1.3, and 5.6 MHz to represent bandwidths that may be encountered with "unlicensed-devices." In addition, the unlicensed device antenna was separated from the television receiver antenna at varying distances from 3 to 24 meters – either line-of-sight or with an intervening wall constructed of drywall plaster board with steel studs (typical of apartment or office fire protection walls).

The results and test procedures are presented in detail in Appendix 1 of this report. The findings demonstrate that there is a definite de-sensitization of the TV receiver caused by emission of the unlicensed device into the TV channel. The tests were performed on both NTSC and DTV receivers. Five DTV receivers were tested on channel 48 at distances of 3, 12, and 24 meters from the interfering source. The results are illustrated in Figure 2. It is important to note that the de-sensitization of the DTV receiver continues to be significant

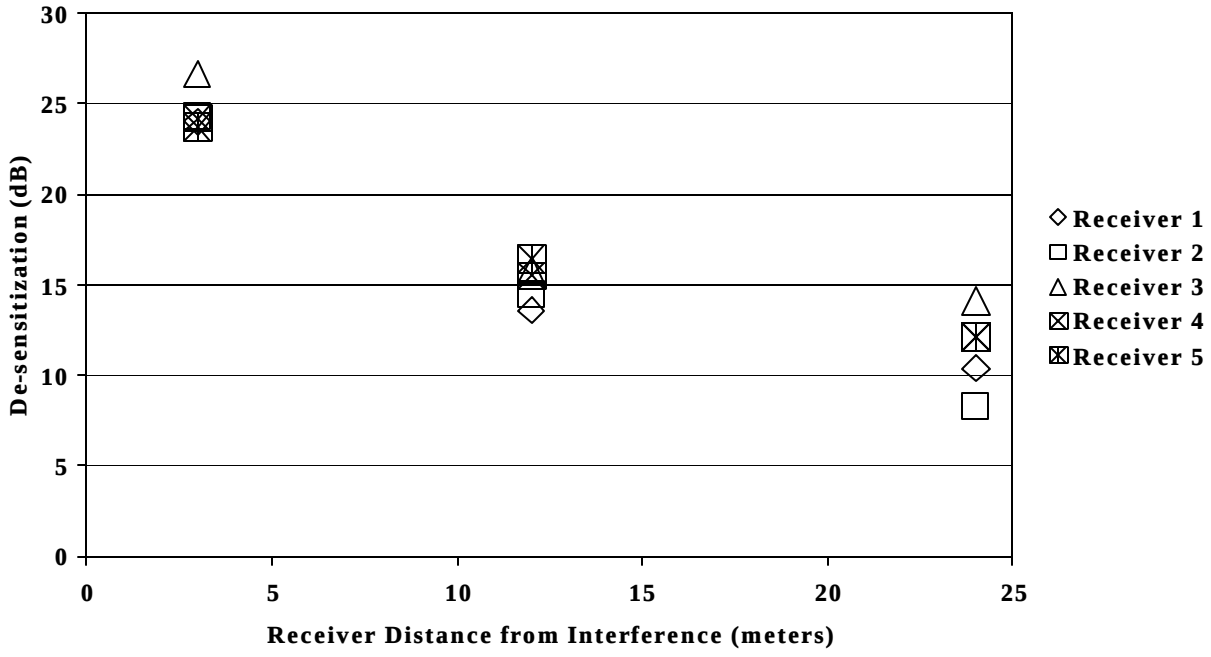


Figure 2 - De-sensitization of DTV receivers by out-of-band interference from a single unlicensed device with a wideband (5.6 MHz) emission into the TV channel.

[10] 47 C.F.R. § 15.209 (a)

even at 24 meters by more than 10 dB. Any DTV receiver operating near the limit of its sensitivity, as may be encountered indoors, would be adversely affected by the interference from an "unlicensed device".

A narrowband emission into the TV channel was also found to desensitize the DTV receiver. Figure 3 illustrates the effect of a 0.43 MHz narrowband emission on the five DTV receivers. Although the total power in the TV channel is 11.2 dB less than the 5.6 MHz case, there still remains a significant impact on the sensitivity of the TV receiver even 24 meters from the unlicensed device.

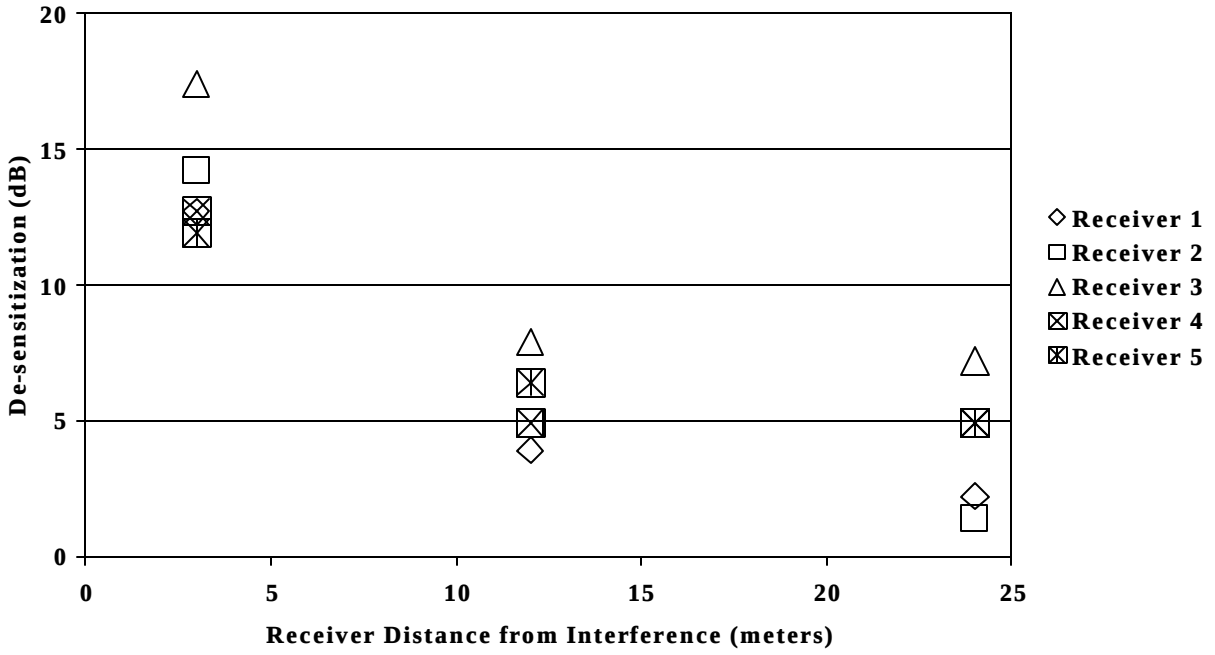


Figure 3 - De-sensitization of DTV receivers by out-of-band interference from a single unlicensed-device with a narrowband (0.43 MHz) emission into the TV channel.

The TV receiver is susceptible to interference even if there is an intervening wall as may be encountered in an office environment or apartment. Figure 4 illustrates the impact of a wall placed between the source of interference and the TV receiver at 12 meters.

Although the wall does attenuate the signal, the DTV receiver is still desensitized by more than 10 dB.

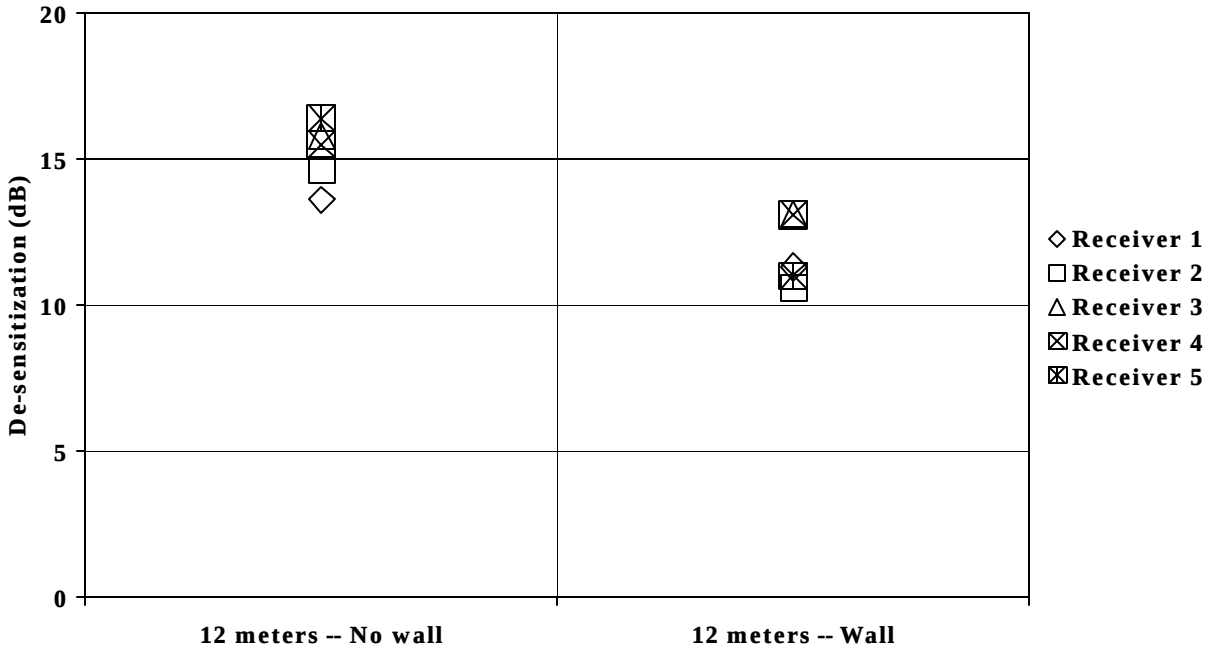


Figure 4 - De-sensitization of DTV receivers by out-of-band interference through a wall from a single unlicensed device with a wideband (5.6 MHz) emission into the TV channel.

The impact of interference on the desensitization of an NTSC receiver is even greater than that for DTV. The interference is so pronounced that the test bed could not provide sufficient desired power to determine the desensitization at the threshold of visibility (TOV). Consequently, the ITU-R Grade 3 ("slightly annoying") criterion was used in the NTSC tests. It should be noted in the test results that the desensitization at TOV is at least 10 dB higher than at ITU-R Grade 3. Figure 5 illustrates the level of desensitization for three NTSC receivers at 6 and 18 meters from the interfering source

using ITU-R Grade 3. Even when the NTSC receiver is placed 18 meters from the interfering source, there is a significant adverse impact on TV reception of at least 15 dB.

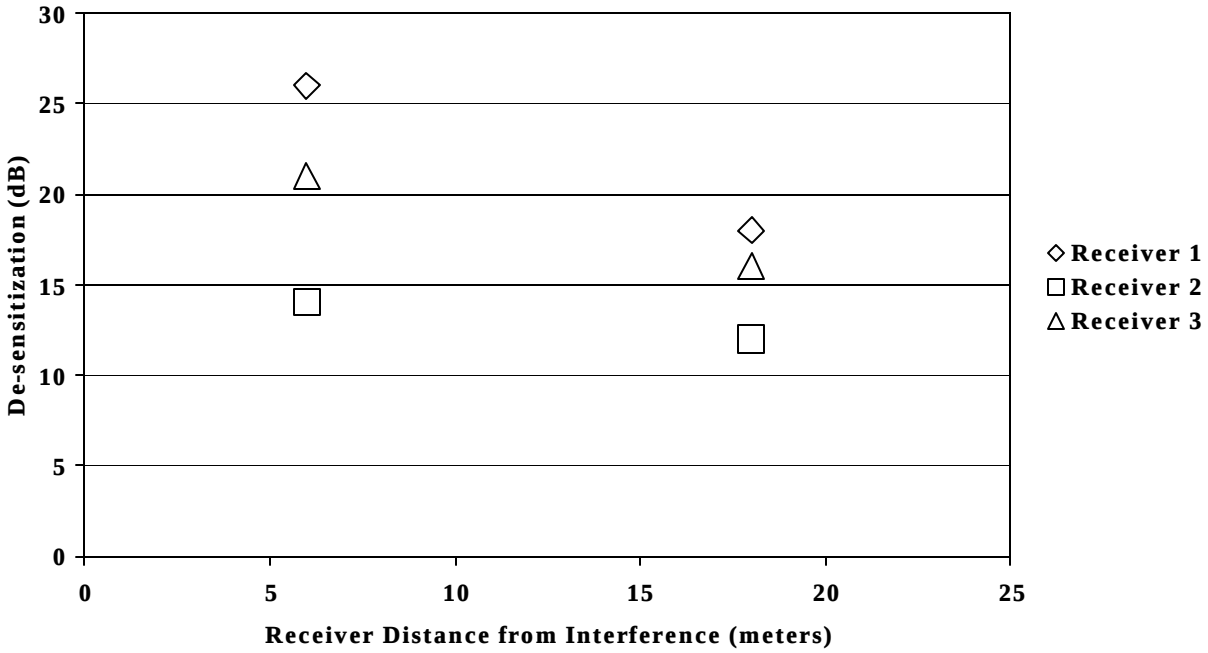


Figure 5– De-sensitization of NTSC receivers by out-of-band interference from a single unlicensed device with a wideband emission (5.6 MHz) into the TV channel.

3. Assessment of Available Spectrum for Unlicensed Devices

The goal of the spectrum assessment is to objectively determine the geographical range over which spectrum could be available within the broadcast TV bands for use by unlicensed devices. The NPRM proposes to allow fixed unlicensed transmitters to operate in "vacant" TV channels provided various desired-to-undesired (D/U) signal ratios are met at all points within the service area of the unlicensed transmitter. The desired signals are the broadcast TV stations either on co-channel or adjacent channels to the undesired unlicensed transmitter.

TechWare, Inc. of Chantilly, Virginia, was commissioned by MSTV to conduct a study to determine the availability of vacant spectrum within the TV bands for use by these unlicensed devices. The study uses the same propagation curves (FCC broadcast curves) proposed in the NPRM to compute the field strengths for both the desired and the undesired signals to identify the areas where these unlicensed transmitters could be placed. The study modeled a grid of fixed unlicensed transmitters representing a network of unlicensed devices that was superimposed at different geographic regions within the US to determine the number of vacant channels available at these locations. The study used a four watts Effective Radiated Power (ERP) for the unlicensed transmitter with an omni-directional antenna placed at every intersection of a 30-second grid (latitude and longitude) across major populated regions of the United States. The unlicensed transmitter height was set at a **modest height of 30 meters (HAAT)** and the number of available channels was determined for each 30-second grid (i.e. approximately a one square mile area). The proposed protection ratios and service contours describe in Appendix B of the NPRM, §15.244(g) and §15.244(h) were incorporated into the software model and computed on 30-second grid (latitude and longitude) intervals.

Figures 6, 7, 8 and 9 presents maps that show the availability of TV channels for unlicensed devices for the North East region of the US, the states of California, Florida and North Carolina respectively. The maps are color-coded to identify the number of TV channels available for unlicensed device operation in a given location and an olive green-colored background to identify the areas where the software model did not determine the availability of vacant channels. Figure 6 shows that, while some TV channels are available for unlicensed fixed operation in certain rural areas, little if any TV channels are available in congested areas, primarily along the Boston-Richmond corridor.[11] Figures 7, 8 and 9 also show similar results.[12] These maps show that while a limited number of TV channels are available in the rural areas, no channels are available in Los Angeles, San Diego, San Jose, San Francisco, Miami-Fort Lauderdale or the Tampa-Orlando urban areas, as well as Charlotte and Raleigh-Durham urban areas. Other urban areas such as Dallas (Figure 10) and Phoenix (Figure 11) showed similar results. Moreover, the spectrum availability in these states and urban areas varies significantly from one geographical grid to another. As shown in the North East region and the state of North Carolina maps, it is nearly impossible to establish large enough areas with sufficient channels to permit operation of unlicensed device networks in the television broadcast spectrum. Furthermore, identifying these white spaces require complex engineering evaluation and analysis to determine where these devices will be allowed to be located. It will also require the proper design and careful installation of these fixed transmitters. These requirements make it extremely

[11] Our analysis indicates that approximately two-thirds of the population in the Boston-Richmond corridor (Figure 6) will not have access to any spectrum. Another 14% will only have access to one TV channel. At 60 meters HAAT, the number of population without access to spectrum is *significantly* higher.

[12] Our analysis further indicates that approximately three-quarters of the population in the state of California (Figure 7) will not have access to any spectrum. An additional 7% will only have access to one TV channel. At 60 meters HAAT, the number of population without access to spectrum is *significantly* higher.

difficult, if not impossible, for untrained unlicensed device operators to conduct these analysis and/or install these transmitters without proper guidance and/or oversight by the Commission or responsible entities.

Similar findings were observed in other regions of the United States. The Techware analysis generally concluded that, using the FCC proposed parameters for protecting TV reception, little if any TV channels are available for unlicensed device operation within the broadcast TV band in the major metropolitan areas of the United States. Television channels are only available in the less populated and rural areas of the country.

Figure 6: Map Depicts Availability of Unlicensed Devices Channels in the North East Region of the United States

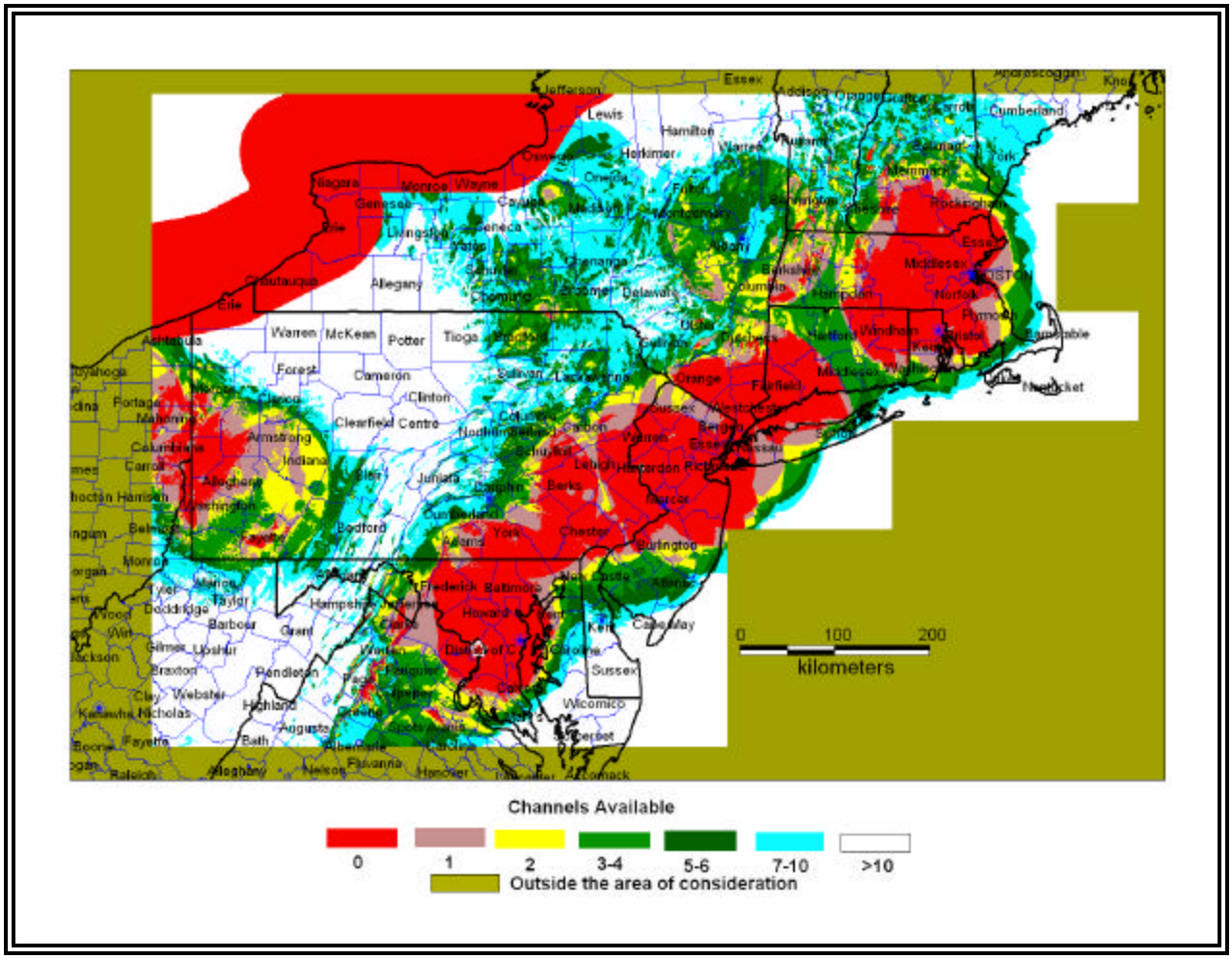


Figure 7: Map Depicts Availability of Unlicensed Devices Channels in the State of California

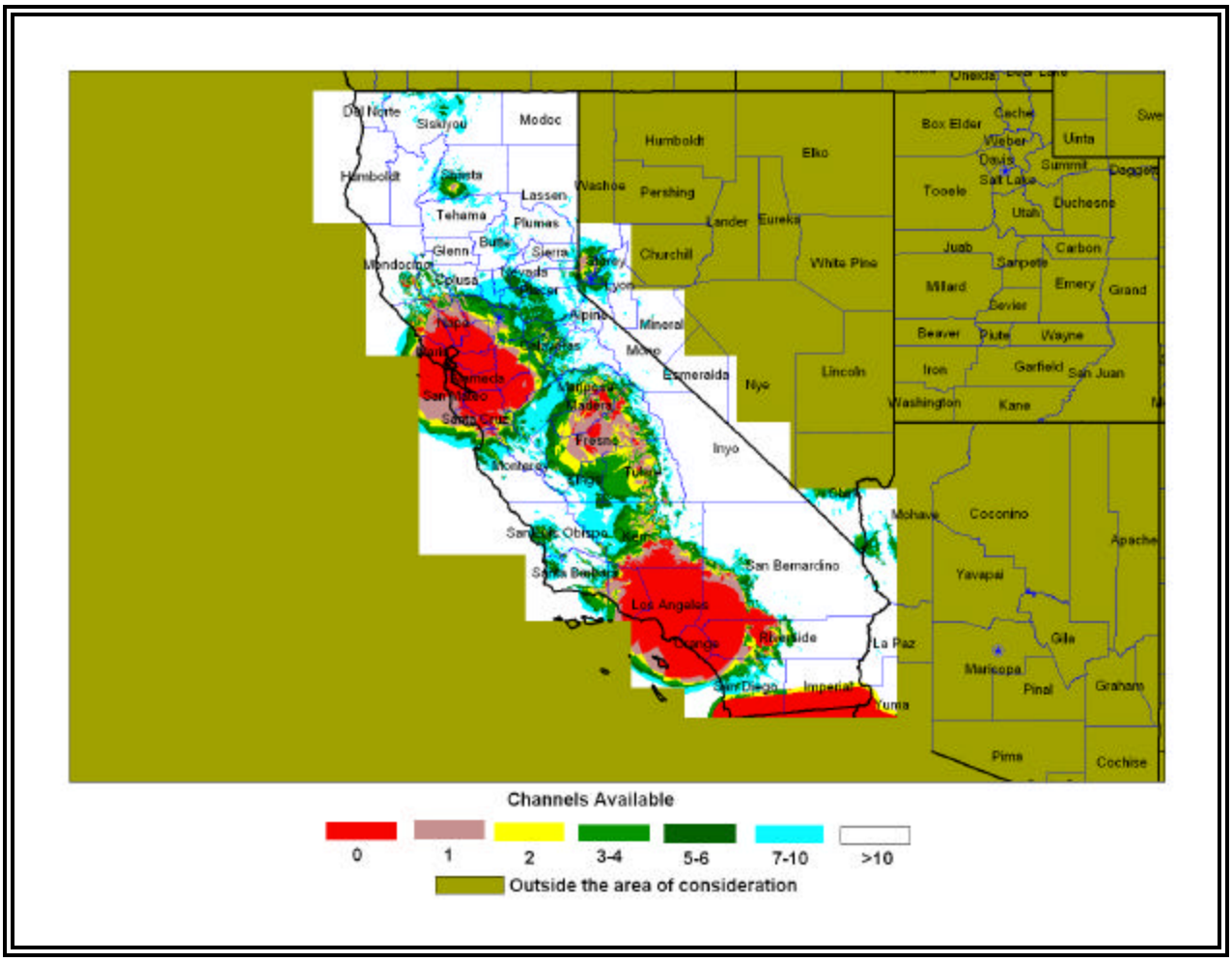


Figure 8: Map Depicts Availability of Unlicensed Devices Channels in the State of Florida

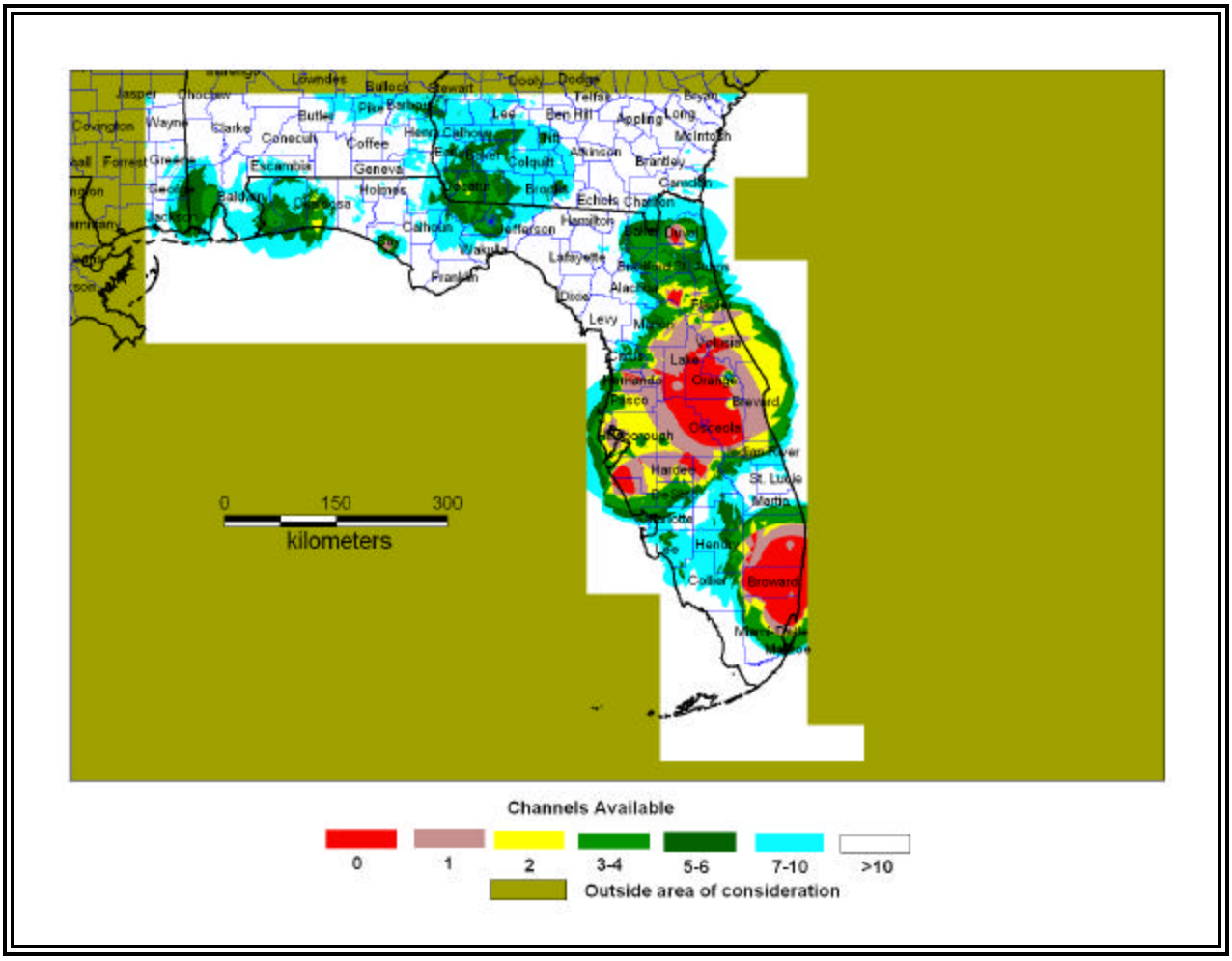


Figure 9: Map Depicts Availability of Unlicensed Devices Channels in the State of North Carolina

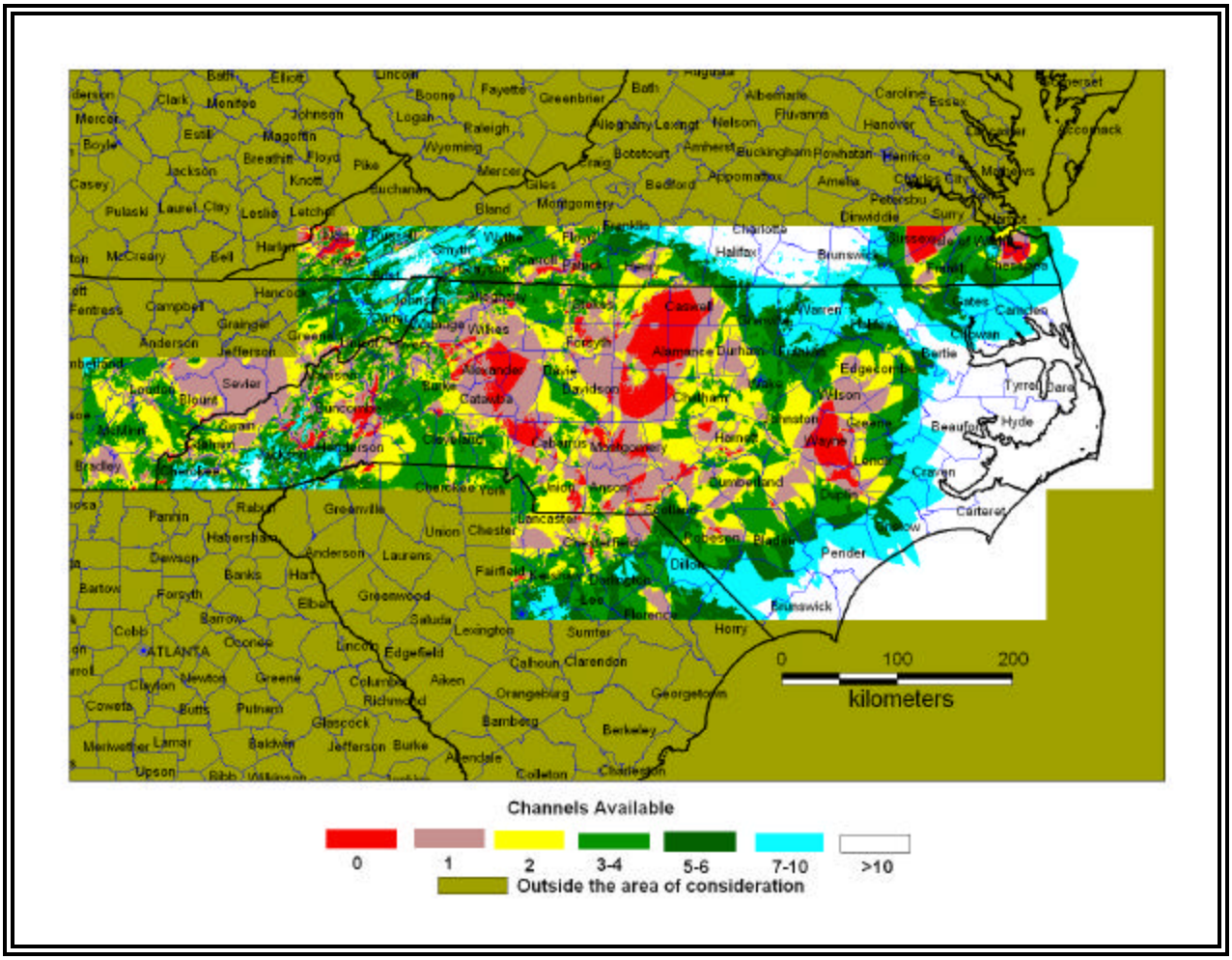


Figure 10: Map Depicts Availability of Unlicensed Devices Channels in the Dallas Urban Area

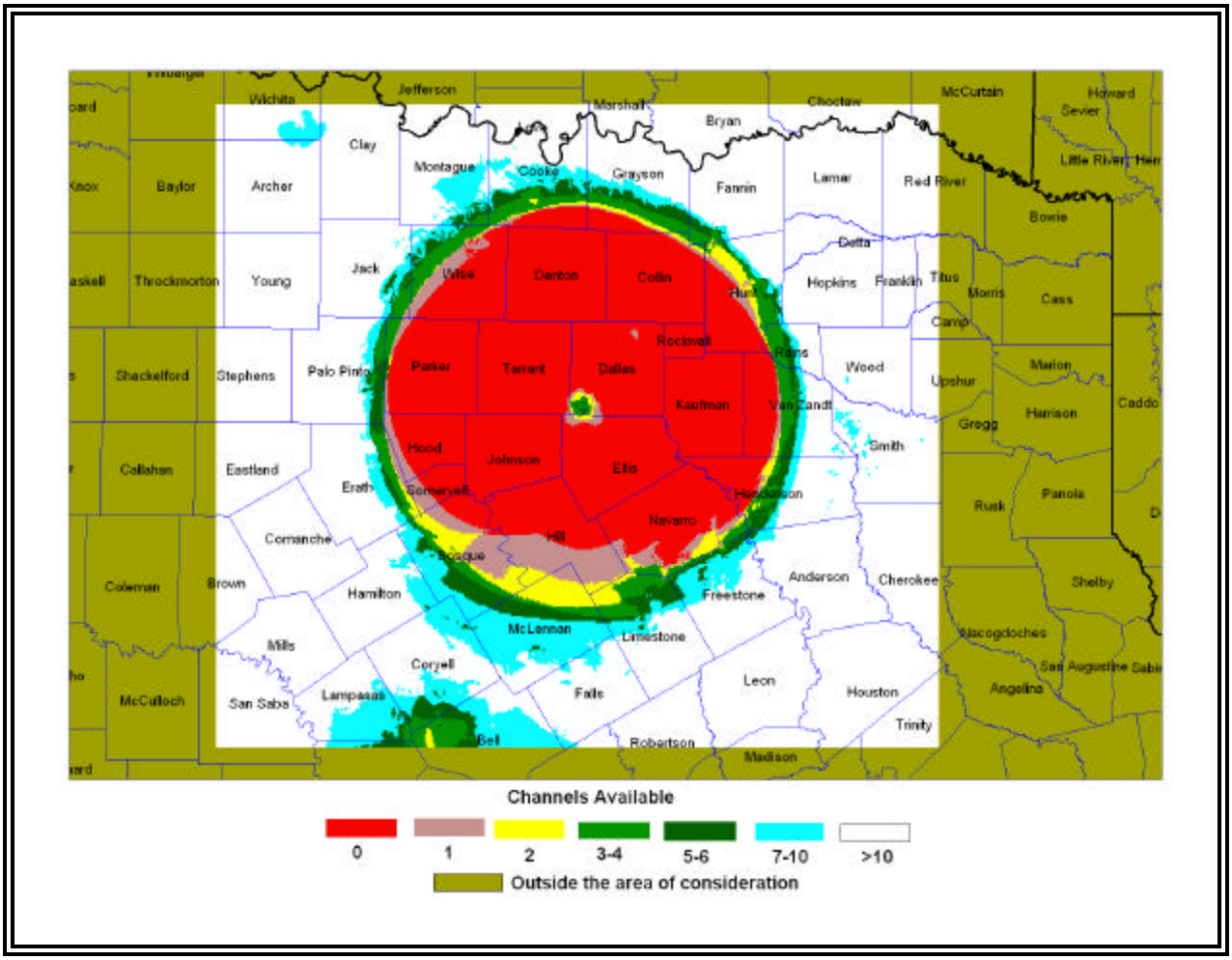
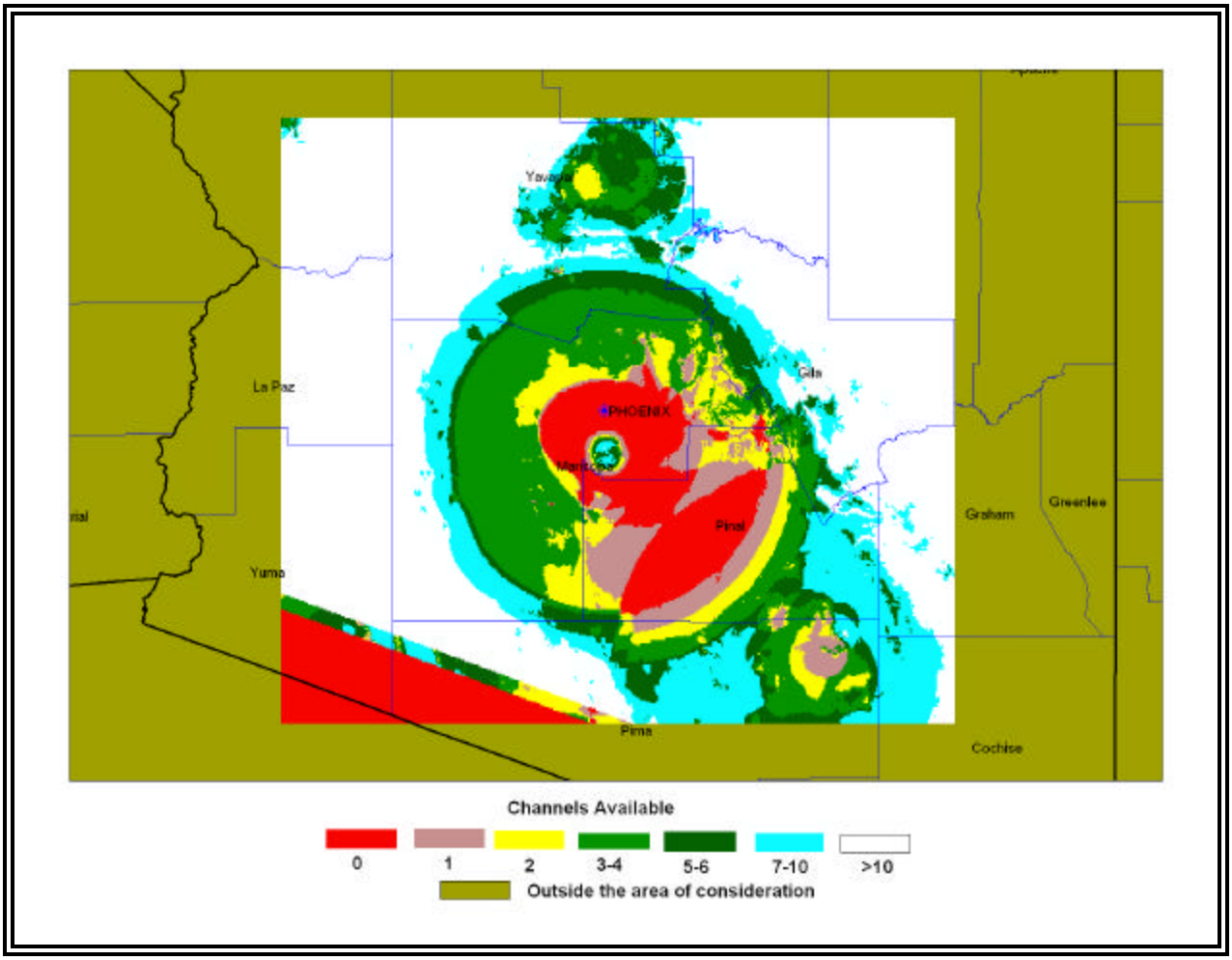


Figure 11: Map Depicts Availability of Unlicensed Devices Channels in the Phoenix Urban Area



4. Conclusions

Unlicensed devices operating in the broadcast TV bands with the proposed levels for out-of-band emissions will cause interference to TV reception. The interference is particularly prevalent for indoor reception where the TV receiver is operating near the limits of its sensitivity. The interference from an unlicensed device desensitizes the TV tuner, thereby reducing the margin for successful reception.

Unlicensed devices operating in the broadcast TV bands are not appropriate for major urban areas. Interference, in the form of receiver desensitization, was found to occur at separation distances likely to be found in office situations, apartments, condominiums, and even suburban environments.

The availability of spectrum within the broadcast TV bands is severely limited for unlicensed devices. It was found that in order to meet the FCC rules for protection contours and protection ratios, there is no spectrum available within major metropolitan areas of the United States.

5. Engineering Credentials

Victor Tawil

Senior Vice-President, Association for Maximum Service Television

Mr. Tawil is Senior Vice President of the Association for Maximum Service Television, Inc. (MSTV), providing technology and telecommunication policy guidance and support to MSTV and its more than 400 member television stations. He was Chairman of the Digital Television Station Project (WHD-TV), sponsored by the television and consumer electronics manufacturing industries and is a member of the Board of Directors of the Advanced Television Systems Committee (ATSC).

Prior to joining MSTV in 1988, Mr. Tawil was with the Federal Communication Commission for fourteen years. He held various positions in a number of Bureaus and the Office of Science and Technology, specializing in the fields of spectrum management, tropospheric propagation and system engineering. He has worked extensively in the areas of broadcasting, satellite, wireless communications and new communication technologies. During his tenure at the FCC, he served as a US delegate on a number of International and ITU Plenipotentiary Conferences, and bilateral negotiations.

Mr. Tawil holds an MSE in Electrical Engineering from the University of Rochester, and a BSE from New York University. He is a member of the International Union of Radio Scientist (URSI), Institute of Electrical and Electronic Engineers (IEEE) and the Society of Motion Picture and Television Engineers (SMPTE) and Tau Beta Pi.

Charles W. Einolf, Jr.

RF Consultant

Dr. Einolf is currently a consultant for the television broadcast industry. He has 36 years of experience in the field of electrical and electronics engineering with extensive experience in the design and development of advanced electronic systems incorporating sensor, computer, communication, and signal processing techniques. Dr. Einolf has provided leadership in broadcast systems, digital TV transmitters, CATV systems, digital microwave, satellite communications, local area networks, personal communication networks, ATM, ISDN, FDDI, analog and digital circuit design, and instrumentation.

Dr. Einolf was the Deputy Executive Director of the Advanced Television Technology Center (ATTC) until the completion of its mission in 2003 to facilitate the transition to Digital Television in the United States. At the ATTC, he was responsible for technical programs that included the improvement of DTV system performance, characterization of signal propagation, and evaluation of audio and video quality.

Dr. Einolf holds the Ph.D. and M.S. degrees in Electrical Engineering from the University of Rochester and a B.S. degree in Electrical Engineering from the Massachusetts Institute of Technology. He has published numerous papers and holds 14 U.S. patents.

Dr. Einolf is a Fellow in the Institute of Electrical and Electronics Engineers and has been awarded the IEEE Centennial and Millennium medals. He is Vice-President of the IEEE Broadcast Technology Society. Dr. Einolf is a Life AdCom member and President-Elect of the IEEE Industrial Electronics Society.

APPENDIX 1

Laboratory Evaluation of Unlicensed Devices Interference to NTSC and ATSC DTV Systems in the UHF Band

REPORT

By

The Communication Research Centre Canada
(CRC)

For

The Association of Maximum Service Television
(MSTV)

November 29, 2004

Table of Contents

Executive Summary

This report presents the results of measurement made to assess the interference potential to DTV and NTSC television reception from the side-lobe emissions of an Unlicensed Device (UD) operating in the UHF band, which comply with the Section §15.209(a) of the FCC Rules. Section §15.209 (a) of the FCC Rules specify a radiated emission limit of 200 uV/m at a measurement distance of 3 meters over frequency range of 215-960 MHz. The emission limit is based on measurement employing an International Special Committee on Radio Interference (CISPR) quasi-peak detector with a measurement bandwidth of 120 kHz.

In general, today's ATSC DTV receiver minimum signal level is in the range of –78 dBm to –83 dBm (over 6 MHz BW), which is equivalent to a noise floor of –93 dBm to –98 dBm. Measurement results show that the proposed Unlicensed Device side-lobe emission limit will cause significant de-sensitisation to DTV and NTSC receivers over a wide area. This is because the proposed emission limit is much higher than the receiver equivalent noise floor (–60 dBm to –70 dBm over a 6 MHz BW). The level of de-sensitisation depends on the interference signal power bandwidth, distance to the interference source, receiver performance, and test environment (indoor, outdoor, etc.).

Tests were conducted in an indoor environment to determine the desensitisation to digital television reception from unlicensed device side-lobe radiated emissions in the clear and when the side-lobe radiated emissions are transmitted through a wall. The data shows that for a distance of 3 meters, an unlicensed device operating with signal bandwidths of 5.6 MHz and 0.43 MHz will de-sensitise DTV receivers an average of 24.5 dB and 13.8 dB, respectively. Similarly, at a distance of 12 meters, the average de-sensitisation is 15.2 dB and 5.6 dB respectively. At 24 meters, the average de-sensitisation is 11.4 and 4.1 dB respectively. Moreover, even when a dry wall is separating an unlicensed device and a DTV receiver, an average de-sensitisation of 19.7 dB and 15.2 dB were measured at distances 5 and 12 meters respectively, when the unlicensed device is operating with a signal bandwidth 5.6 MHz.

Similar test were also conducted for NTSC receivers. The data shows that an even greater desensitisation for NTSC, when compared to DTV. For a wideband interference signal (5.6 MHz) at 18meters from an analog television receiver, assuming ITU-R Grade 3 picture quality, the average desensitisation is 15.3 dB. For a narrowband signal (0.43 MHz), the desensitisation will depend on the location of the interference signal relative to the video and colour carrier of the NTSC signal and generally follows the traditional behaviour of the "S" curve. When placed in the middle of the TV channel, the average de-sensitisation at 18 meters is 5.6 dB. At a 6 meters distance, the desensitisation ranges from 5 dB to 18 dB depending on the location of the interference signal relative to the video and colour carrier of the NTSC signal. If the Threshold Of Visibility (TOV) is used as the picture quality threshold, a 10 dB correction (more desensitisation) should be added over the ITU-R Grade 3 case.

The UD could also cause cable ingress, especially for a single shielded RG-59 cable. The ingress level can be up to –44 dBm regardless of whether the cable is terminated or not.

Introduction

On May 25, 2004, the FCC released a Notice of Proposed Rule Making (NPRM) that proposes to allow unlicensed radio transmitters to operate in the broadcast television spectrum at locations where that spectrum is not being used. CRC was contracted by MSTV to conduct measurements to investigate the possible impact of interference from the unlicensed devices on the current DTV and NTSC services.

Based on the FCC NPRM, the proposed Unlicensed Devices (UD) "radiated emissions that fall outside the TV broadcast channel(s) where the device operates must comply with the radiated emission limits specified in §15.209(a)". Section 15.209(a) of the FCC rules state that "*the radiated emission limits over frequency band of 215-960 MHz is 200 dBuV/m at a measurement distance of 3 meters".* The emission limit is based on measurement employing a CISPR quasi-peak detector with a *measurement bandwidth of 120 kHz*.

Based on the Commission proposal, CRC conducted measurement to characterise the de-sensitisation of ATSC DTV and NTSC receivers from the side-lobe radiated emissions of an unlicensed portable device. Specifically the following laboratory evaluations were performed:

- De-sensitisation of DTV receivers in an indoor environment.
- De-sensitisation of DTV receivers with UD sideband signals transmitted through a dry wall.
- De-sensitisation of NTSC receivers in an indoor environment.
- De-sensitisation of NTSC receivers with the narrowband signal transmitted across the NTSC channel.
- Cable ingress created by the UD signals.

Laboratory Test Set-up

The Unlicensed Devices interference emissions signals were generated using a COFDM modulator provided by CRC. The UD emission signals were generated by CRC in such a way as to meet the FCC emissions requirement. (i.e. 200 uV/m, or 46 dBuV/m within a 120 kHz bandwidth). The interfering emissions signals were measured at 3 m from the unlicensed devices, within a 120 kHz bandwidth. The UD interfering emitted signal power level was adjusted to 3 dB below the FCC emission requirement to avoid any impact of measurement error on the measurement results. The generated unlicensed devices interference emission signals were up-converted, filtered and inserted on the desired DTV or NTSC channel. List below is a summary of the relevant parameters and calculations used to conduct these tests:

FCC emission limit: 200 uV/m, or 46 dBuV/m within 120 kHz

Convert to dBm: P (dBm) = –75.5 + 46 dBuV/m – 20 log(Frequency in MHz)

= –29.5 – 20 log (Frequency in MHz)

Interference signal parameters:

- Modulation: 64QAM-OFDM;
- 3-dB bandwidth: 5.57 MHz (wideband), 1.29 MHz (mediumband), 3 x 0.43 MHz, and 0.43 MHz (narrowband)
- Number of OFDM carriers: 5616, 324, 324, and 108;
- Guard interval: 1/16; 64QAM modulation.

***To avoid measurement error, the interference level is set at 3 dB below the FCC specified limit,* thus**:

- For CH-48 (677 MHz), the interference level is –29.5 – 20 log (677) – 3 = –89.1 dBm within 120 kHz.
- For CATV CH-66 (477 MHz), the interference level is –29.5 – 20 log (477) – 3 = –86.1 dBm within 120 kHz. (Note: a CATV NTSC modulator is used in the NTSC system test. CATV and off-air TV have different frequency range, but they all use the same 6 MHz NTSC signal. CATV CH-66 is equivalent to UHF off-air Channel 14 and 15.)

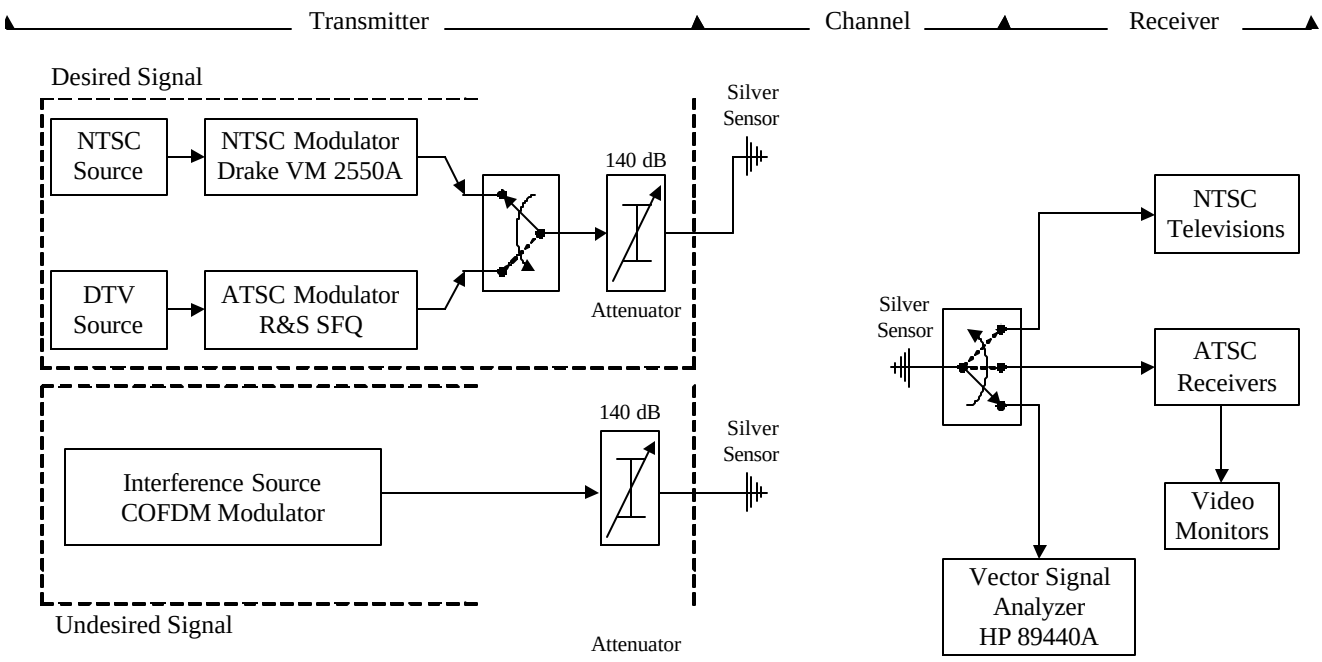


Figure 1 - Laboratory Test Set-up for the Evaluation of UD Emissions Impact on TV Signals.

In the above calculation, a simple dipole antenna is assumed. The emission limit field strength is converted into signal power (dBm). In the laboratory test, the interference power level is adjusted by varying the transmission power. The receiving power calibration is done at 3m from the emission point for the power levels calculated above.

The laboratory set-up for the evaluation of the ATSC 8-VSB receiver is presented in Figure 1. The set-up is divided into three sections: Transmitter, Channel and Receiver.

The laboratory measurements were conducted for distances between the UD and the DTV receivers of 3 m, 12 m and 24 m; for the NTSC case, the distances were 6 m and 18 m. (Note: Since the NTSC signal is more sensitive to interference, the test points for NTSC system is further away than for the DTV system). Tests were also conducted with the undesired signals transmitted through a wall (typical commercial office dry-wall) and the resulting receiver de-sensitisation measurement recorded. The test procedures are attached (Annex 1).

The Threshold of Visibility (TOV) was recorded for viewing DTV pictures over a 20 seconds period. The ITU-R Grade 3 performance (slightly annoying audio, video, colour) for NTSC was also recorded. The power levels recorded were in 1-dB step-size.

The tests were conducted using one video sequence for DTV and one video test pattern for NTSC (colour bar). The tests investigated the de-sensitisation effects due to UD interference using five different DTV receivers and three different NTSC receivers.

The tests were done on Off-Air Channel 48 (674-680 MHz) for DTV. Since only a cable TV NTSC modulator was available, the NTSC tests were performed in the 474 to 480 MHz band (CATV Channel located in the off-air Channel 14 and 15). All NTSC receivers used in the test have cable ready tuner. There are no over-the-air signals on Channel 14 and 15 in the Ottawa area where the tests were conducted.

As a reference, Figure 2 shows the off-air spectrum plots of 674-680 MHz and 474-480 MHz. It is noteworthy that there is no other interference source detected in these spectrum bands.

Four different UD interference signals were used with a 3 dB bandwidths of 5.6 MHz, 1.3 MHz, 3 x 0.43 MHz and 0.43 MHz. The spectrums of the signals are presented in Figures 3, 4, 5 and 6. Based on the spectrum plots, there is little, if any, multipath distortion at a 3m site.

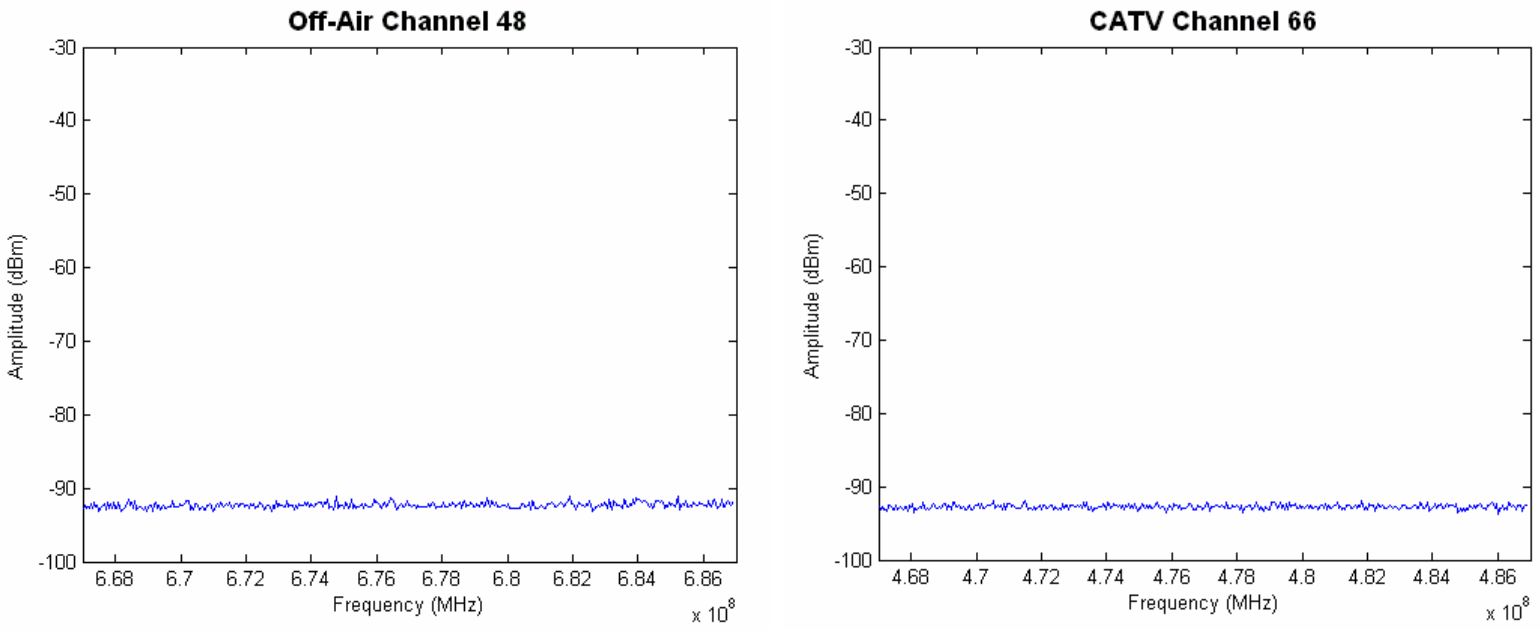


Figure 2. Off-Air Spectrum Plots of 674-680 MHz (DTV Tests) and 474-480 MHz (NTSC Tests)

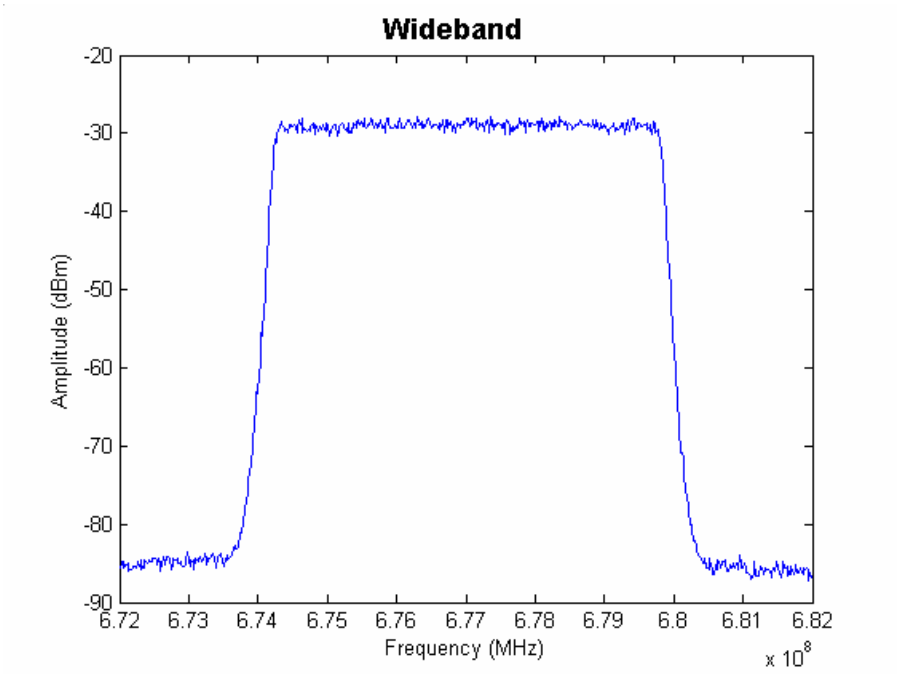


Figure 3. Spectrum of the Wideband Signal with a 3 dB Bandwidth of 5.6 MHz Received at 3 Meters.

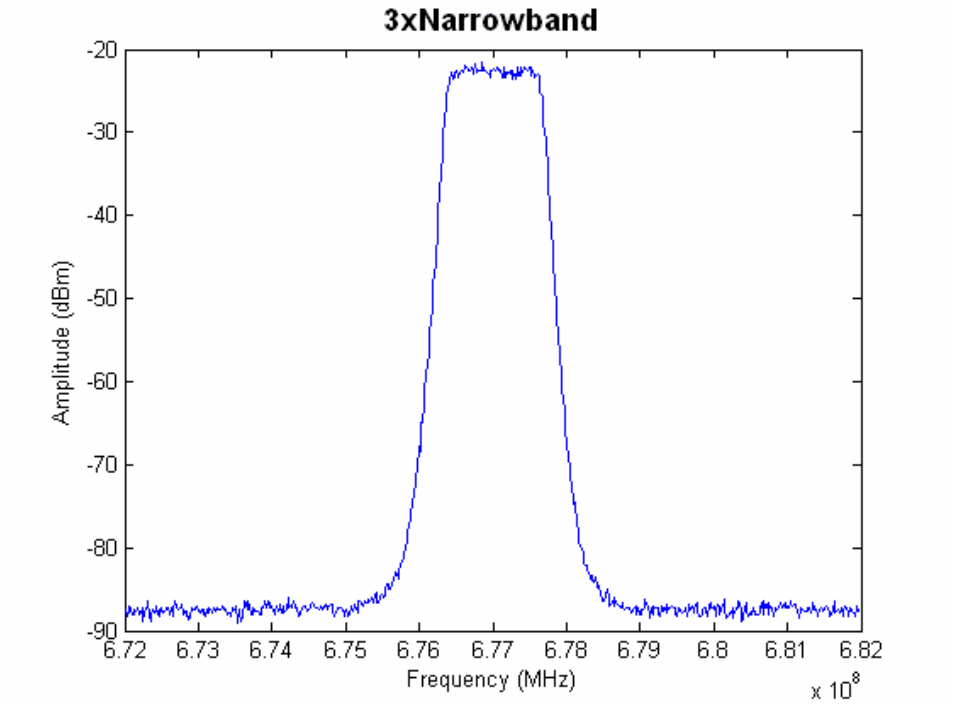


Figure 4. Spectrum of Mediumband Signals with a 3 dB Bandwidth of 1.3 MHz Received at 3 Meters.

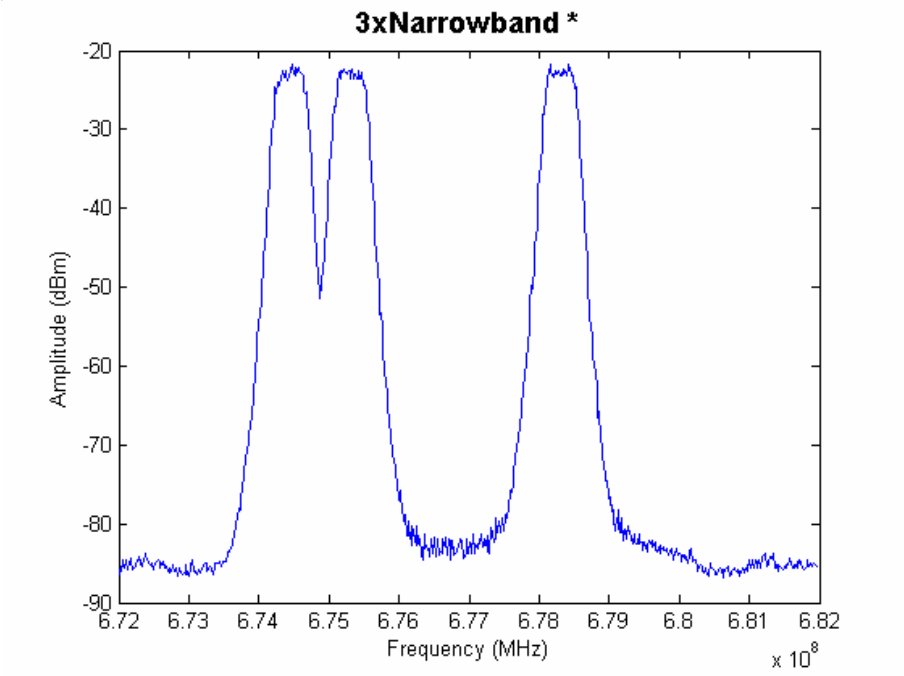


Figure 5. Spectrum of 3 x 0.43 MHz Narrowband Signals Distributed over the DTV Channel Received at 3 Meters.

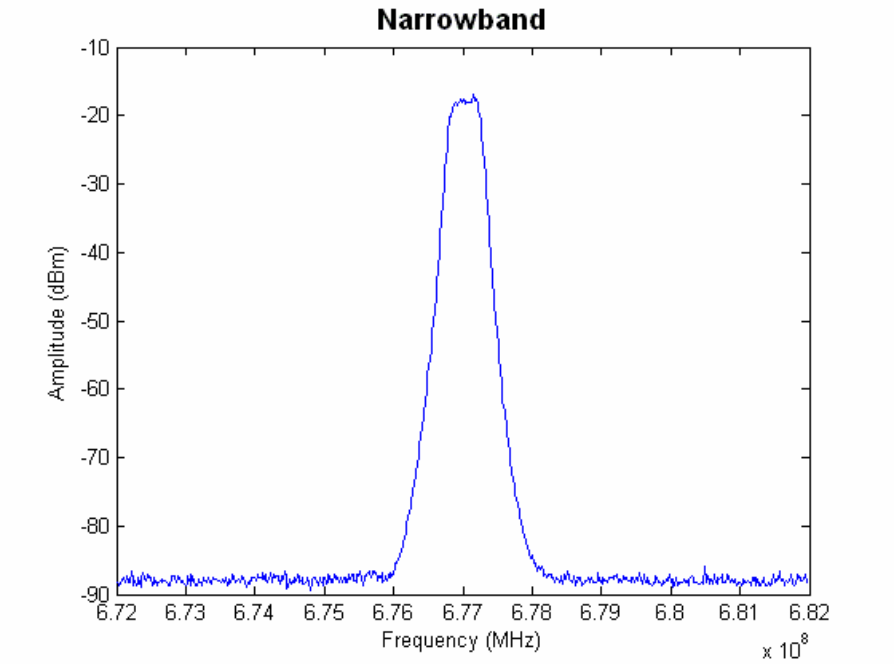


Figure 6. Spectrum of the Narrowband Signal with a 3 dB Bandwidth of 0.43 MHz Received at 3 Meters.

Results Of The Laboratory Test

The results of the following laboratory experiments listed below are presented in this section:

- De-sensitisation of DTV receivers in an indoor environment.
- De-sensitisation of DTV receivers with UD sideband signals transmitted through a dry wall.
- De-sensitisation of NTSC receivers in an indoor environment.
- De-sensitisation of NTSC receivers with the narrowband signal transmitted across the NTSC channel.
- Cable ingress created by the UD signals.

1.1 De-Sensitisation of DTV Receivers In An Indoor Environment

The DTV signal and the UD sideband signals were transmitted and received in the same room. The calibration was done at a distance of 3 m from the DTV receiver as specified by the FCC NPRM and explained in the test procedure in Annex 1. The interference signal power was adjusted to obtain -89.1 dBm/120 kHz at 3 meters.

For the 5.6 MHz wideband signal, the total interference power can be calculated as –89.1 + 10 log (5.6/0.12) = -72.4 dBm. For the 1.3 MHz and 3 x 0.43 MHz bandwidth signals, the total interference power is –89.1 + 10 log (1.3/0.12) = -78.8 dBm. For the 0.43 MHz narrow-band signal, the total interference power is –89.1 + 10 log (0.43/0.12) = -83.6 dBm. In all cases, the interference power levels were more than 50 dB below the recommended portable UD indoor power level at 3m-reference point.

A total of five DTV receivers were used in these tests.

The tests were conducted on Off-Air channel 48 (674 – 680 MHz). The results are presented in Table 1, 2 and 3 for the tests conducted at 3 m, 12 m and 24 m respectively.

Table 1. De-Sensitisation of DTV Receivers At 3 Meters.

Off-Air Channel 48	DTV Receiver #1	DTV Receiver #2	DTV Receiver #3	DTV Receiver #4	DTV Receiver #5
Rx Sensitivity	-80.5 dBm	-81.0 dBm	-81.9 dBm	-80.6 dBm	-80.1 dBm
De-sensitisation at 3 meters					
Wideband	24.0 dB	24.3 dB	26.6 dB	24.2 dB	23.7 dB
Mediumband	17.7 dB	18.6 dB	21.7 dB	17.7 dB	16.9 dB
3 x Narrowband*	18.1 dB	18.6 dB	22.5 dB	18.3 dB	17.2 dB
Narrowband	12.7 dB	14.2 dB	17.4 dB	12.7 dB	11.9 dB

*Three 0.43 MHz carriers distributed over the 6 MHz TV channel

Table 2. De-Sensitisation of DTV Receivers At 12 Meters.

Off-Air Channel 48	DTV Receiver #1	DTV Receiver #2	DTV Receiver #3	DTV Receiver #4	DTV Receiver #5
Sensitivity	-81.3 dBm	-82.2 dBm	-84.9 dBm	-82.6 dBm	-85.0 dBm
De-sensitisation at 12 meters					
Wideband	13.6 dB	14.5 dB	15.8 dB	15.5 dB	16.4 dB
Mediumband	8.8 dB	9.2 dB	13.2 dB	9.6 dB	10.9 dB
3 x Narrowband*	7.4 dB	7.4 dB	11.7 dB	8.7 dB	9.6 dB
Narrowband	3.9 dB	4.9 dB	7.9 dB	4.9 dB	6.4 dB

*Three 0.43 MHz carriers distributed over the 6 MHz TV channel

Table 3. De-Sensitisation of DTV Receivers At 24 Meters.

Off-Air Channel 48	DTV Receiver #1	DTV Receiver #2	DTV Receiver #3	DTV Receiver #4	DTV Receiver #5
Sensitivity	-81.4 dBm	-79.2 dBm	-84.3 dBm	-83.2 dBm	-83.9 dBm
De-sensitisation at 24 meters					
Wideband	10.4 dB	8.3 dB	14.1 dB	12.1 dB	12.1 dB
Mediumband	6.9 dB	4.7 dB	11.9 dB	8.3 dB	8.9 dB
Narrowband	2.2 dB	1.4 dB	7.2 dB	4.9 dB	4.9 dB

It was noticed that the receiver sensitivity varies in a +/-1 dB range for different test points. This is attributed to one or all of these factors: multipath distortion, noise floor variation and other interference mechanisms. It was also noticed that DTV Receiver #3 always showed a higher de-sensitisation than other DTV receivers. This is attributed to Receiver 3 having a more sensitive tuner and being more susceptible to the multipath distortion (requiring a higher S/N under multipath environment).

It was also observed that signal reflection within the building created standing waves. The result of this phenomenon was that the received signal could be up to 3 dB higher than what it would be for free-space propagation. There were also signal "nulls" in the room, which could result in signal level drops of several dB over small changes in location. Moreover, multipath effects were observed to increase as the distance from the transmitter was increased.

1.2 De-Sensitisation of DTV Receivers by UD Sideband Signals Transmitted Through A Wall.

In these tests, the interference signals were transmitted through one wall before reaching the DTV receivers. The walls are typical interior office fire protective dry wall.

The calibration was done at 3 m as explained in the test procedure in Annex 1. Tests were conducted on Off-Air channel 48 (674 – 680 MHz). The interfering signal power was adjusted to be at -89.1 dBm/120 kHz at 3 meters from the receivers. The receivers tested using this interference source are listed in Annex 2.

The results of the test using the various DTV receivers each separated from the interference source by one wall such that the DTV receiver was 5 m from the interference source, which was 3m from the wall, are presented in Table 4.

Table 4. De-Sensitisation of DTV Receivers for Interfere nce Signals Transmitted through One Dry Wall at a Distance of 5 Meters.

Off-Air Channel 48	DTV Receiver #1	DTV Receiver #2	DTV Receiver #3	DTV Receiver #4	DTV Receiver #5
Sensitivity	-80.2 dBm	-81.5 dBm	-82.8 dBm	-80.7 dBm	-82.7 dBm
De-sensitisation at 5 meters (1 wall)					
Wideband	18.1 dB	19.4 dB	21.6 dB	18.6 dB	20.9 dB
Mediumband	11.6 dB	12.6 dB	15.8 dB	11.9 dB	13.6 dB
Narrowband	7.6 dB	8.8 dB	12.6 dB	7.5 dB	9.1 dB

Similarly, tests were conducted at 12 m the results of which are shown in Table 5. For this case the test were conducted with and without a wall between the interference source and the DTV receivers.

The test results show that the interference signal is attenuated by about 3-6 dB, when going through a typical fire rated office drywall.

Table 5. De-Sensitisation of DTV Receivers for Interference Signals Transmitted and Not Transmitted Through One Dry Wall at a Distance of 12 Meters.

Off-Air Channel 48	DTV Receiver #1	DTV Receiver #2	DTV Receiver #3	DTV Receiver #4	DTV Receiver #5
Sensitivity	-80.8 dBm	-81.1 dBm	-82.4 dBm	-82.0 dBm	-81.1 dBm
De-sensitisation at 12 meters (No wall)					
Wideband	13.6 dB	14.6 dB	15.8 dB	15.5 dB	16.4 dB
De-sensitisation at 12 meters (1 wall)					
Wideband	11.3 dB	10.6 dB	13.1 dB	13.1 dB	11.0 dB

1.3 De-Sensitisation of NTSC Receivers in an Indoor Environment

The NTSC and the interference signals were transmitted and received in the same room. The calibration was done at 3m as explained in the test procedure in Annex 1. The interference signal power was adjusted to obtain -86.1 dBm/120 kHz at 3 meters. The lists of the NTSC receivers used in the tests are also presented in Annex 2.

The de-sensitisation tests were carried out on CATV channel 66 (474 – 480 MHz) equivalent to UHF off-air Channel 14 and 15. (Note: a cable TV NTSC modulator was used in the test, as an off-air NTSC modulator was not available. However, this should have no impact on the test results, since there is only a slight frequency range difference, the signal modulation is the same). The results are presented in Tables

6 and 7 for tests conducted for distance of 6m and 18m respectively. The greater than sign ">" indicates that de-sensitisation was beyond the limits of the test-bed.

Table 6. De-Sensitisation of NTSC Receivers at 6 Meters.

CATV Channel 66	NTSC Receiver #1		NTSC Receiver #2		NTSC Receiver #3	
	TOV	ITU-R Grade 3	TOV	ITU-R Grade 3	TOV	ITU-R Grade 3
Sensitivity	-51.5 dBm	-61.5 dBm	-41.5 dBm	-51.5 dBm	-45.5 dBm	-58.5 dBm
De-sensitisation at 6 meters						
Wideband	> 23 dB	26 dB	> 13 dB	14 dB	> 17 dB	21 dB
Narrowband	14 dB	15 dB	2 dB	3 dB	14 dB	14 dB

Table 7. De-Sensitisation of NTSC Receivers at 18 Meters.

CATV Channel 66	NTSC Receiver #1		NTSC Receiver #2		NTSC Receiver #3	
	TOV	ITU-R Grade 3	TOV	ITU-R Grade 3	TOV	ITU-R Grade 3
Sensitivity	-51.5 dBm	-61.5 dBm	-41.5 dBm	-51.5 dBm	-45.5 dBm	-58.5 dBm
De-sensitisation at 18 meters						
Wideband	> 8 dB	18 dB	> 4 dB	12 dB	> 7 dB	16 dB
Narrowband	8 dB	8 dB	2 dB	1 dB	7 dB	8 dB

The test results show that there is more desensitisation for NTSC than that of DTV. This is most likely because the NTSC system requires a higher S/N to operate.

The test also shows that the NTSC Receiver 2 requires 5-10 dB more power (sensitivity) than Receiver 1 and 3 for TOV and ITU-R Grade 3.

1.4 De-Sensitisation of NTSC Receivers with the Narrowband Signal Transmitted Across NTSC Band

The purpose of this test was to study the impact of a narrowband interfering signal positioned at various frequencies across the NTSC channel would have on the NTSC signal itself.

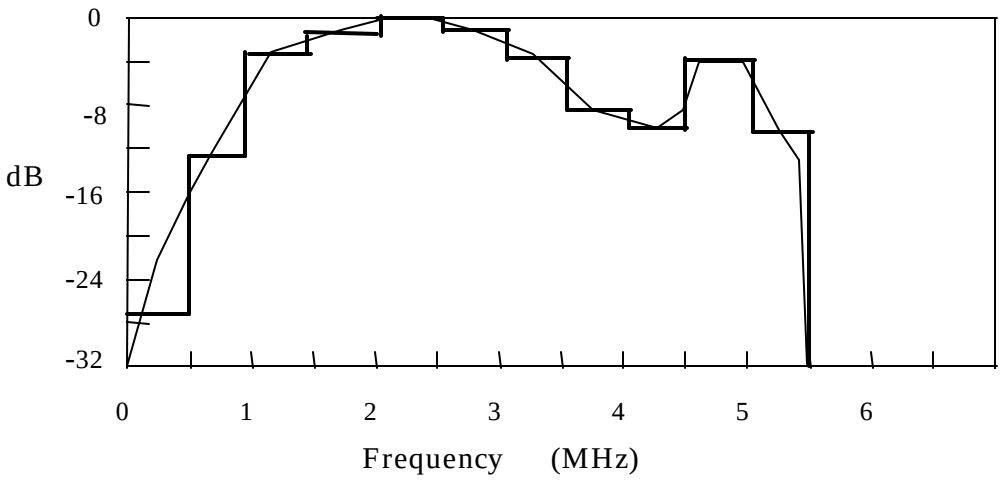
The NTSC signal and the narrowband interference signal were transmitted and received in the same room. The calibration was done at 3m as in previous cases. The interference signal power was then adjusted to obtain -86.1 dBm/120 kHz at 3 meters. The test for this case was completed with only the NTSC receiver #1 (see the list of the NTSC receivers in Annex 2).

Again, CATV Channel 66 (474 – 480 MHz), which is equivalent to UHF off-air Channels 14 and 15, was used for the test. Table 8 presents the test results at 6m and at different frequencies across the NTSC channel. An NTSC visual signal RF subjective weighting curve shown in Figure 7 was used as reference for the interference calculation. Figure 7 shows that the NTSC visual signal is most sensitive to interference positioned between 1.5 and 2.5 MHz above the lower channel edge.

Table 8. De-Sensitisation of NTSC Receivers At 6 Meters For The Narrowband Signal Transmitted Across The NTSC Band

CATV Channel 66	NTSC Receiver #1				
	Center Frequency of the narrowband interference signal				
	474.5 MHz (At 0.5 MHz)	476 MHz (At 2.0 MHz)	477 MHz (At 3.0 MHz)	478 MHz (At 4.0 MHz)	478.75 MHz (At 4.75 MHz)
De-sensitisation at 6 meters					
TOV	4 dB	16 dB	14 dB	14 dB	18 dB
ITUR-3	5 dB	18 dB	15 dB	15 dB	18 dB

Figure 7. NTSC Visual Signal RF Subjective Weighting Curve ("S" Curve).



The test results match well with the NTSC visual signal weighting curve ("S" curve), except at the colour sub- carrier location (about 4.75 MHz from the lower channel edge), where it is more sensitive to the interference. This is because the colour-bar test pattern, which is very sensitive to the colour sub-carrier interference, was used for the subjective assessment.

1.5 Cable Ingress Created by the UD Sideband Signals

The purpose of these tests was to determine the possible cable ingress created by the interfering signals.

For these tests, an indoor portable UD was assumed. This UD was set to transmit a 100-mW wideband signal through a Silver Sensor antenna with about 5-dB gain. The closest distance between the antenna and the cable was about 1 meter. Two types of cable were used. One being an RG-6 double shielded cable; and the other an RG-59 single shielded cable. The length of the cable used in the test was about 10 meters. The cable was stretched across a room with one end connected to a Vector signal analyser for ingress signal power measurement. Tests were conducted with the other end of the cable either terminated in its characteristic impedance or un-terminated. The results of the tests are presented in Table 9.

Table 9. Cable Ingress Created by Wideband Emission Signal.

CABLE INGRESS MEASURED POWER				
FREQUENCY	RG-6 CABLE		RG-59 CABLE	
	NOT TERMINATED	TERMINATED	NOT TERMINATED	TERMINATED
195 MHz	-46 dBm	-69 dBm	-44 dBm	-48 dBm
515 MHz	-55 dBm	-68 dBm	-44 dBm	-46 dBm

The results confirmed, as expected, that the double-shielded RG-6 cable will pick up interference, if it is not terminated (in our test the un-terminated cable end is about 5m away from the transmitting antenna). RG 6 cable is probably the most widely used cable for home installation of cable TV and Satellite TV systems. For the case of the single shielded RG-59 cable, the test show that regardless of weather it is terminated or not, significant ingress interference was detected. Non-professionals to install additional cable outlet at home often use RG 59.

Findings & Observations

1. To avoid measurement errors, the interference signal level was set at 3 dB below the FCC recommended emission limit, thus, the actual receiver desensitisation could be up to 3 dB higher than the measurement results.

2. For different interfering signal bandwidth, the results are very much proportional to the interference signal bandwidth. For example, the wideband interference signal, 5.6 MHz BW, will cause 10 log (5.6/0.43) = 11.1 dB more desensitisation than narrowband interference signal with a 0.43 MHz bandwidth. Test results show that, for each DTV receiver, the discrepancy is within +/- 1 dB over calculated results (see Table 1, 2, and 3). When desensitisation is small as shown in Table 3, the power calculation method is not accurate, since the receiver noise floor will impact the desensitisation. For example, if the interference is at the same level as the receiver noise floor, the desensitisation will be 3 dB rather than 0 dB.

3. It is interesting to note that a 1.3 MHz bandwidth interfering signal has almost the same impact as three individual 0.43 MHz (3 x 0.43 = 1.29 MHz) interference signals (+/- 1 dB accuracy) spread across a TV channel as shown in Tables 1 and 2.

4. Indoor multipath reflection forming standing waves, which results in signal peaks and nulls over few inches distance (RF frequency dependent) were observed. The peak can be 3 dB above free space propagation curve, while nulls can easily cause several dB of signal loss. The further away from the UD, the greater the potential for multipath reflection, which could cause possible desensitisation in extended areas.

5. There was more desensitisation for the case of NTSC than for that of DTV. This result is expected, since the NTSC system requires higher S/N than the DTV system to operate.

6. A narrow band interference signal located in an NTSC channel follows the behaviour of the “S” curve.

ANNEX 1: TEST PROCEDURE

Test Procedure for Unlicensed Devices Interference Signal Emissions into the ATSC DTV and NTSC Channel.

Set Up:

- Select an RF channel between CH14 and 51.

-Make sure there is minimum off-air interference in co- and first adjacent channels.

- Interference emissions signals:
    1. Wideband emission signal, 5.6 MHz BW
    2. Narrowband emission signal, 0.429 MHz BW
    3. Mediumband emissions signals, 1.3 MHz BW
    4. Three narrowband emissions signals distributed over the 6 MHz channel, 3x0.43 MHz
- Interference signal power level set up:
    - FCC emission requirement: 200 uV/m, or 46 dBuV/m within a 120 kHz BW.
    - Convert to dBm: P(dBm) = -75.5 + dBuV/m – 20 log(Frequency in MHz)
    - The emission signal level should be measured at 3m from the unlicensed devices, within a 120 kHz BW.
    - The signal level should be 3 dB below the above calculated emission level P(dBm) to avoid possible measurement errors. Since allowed interference signal power is calculated and fed to the receiver directly, the type of antenna used for transmission and reception is irrelevant.

- Wanted signal:
    - ATSC DTV and NTSC.
    - TOV is used as the test threshold.
    - Test point: 3m, 12m and 18m away from the unlicensed devices.
    - Tests will also be done with signals transmitted thought a wall.
    - Television channel multipath distortion should be minimum.

DTV TEST

1. Test at 3m with wideband and narrowband interference emissions signals:

- At 3m, measure the off-air interference level (co- and first adjacent-channels), and the equipment noise level in 6 MHz and in 120 kHz bandwidth;
- Adjust interference emission signal power level, measured 3m away, to be P(dBm) – 3 dB over the 120 kHz BW;
- Turn off the interference, transmit ATSC DTV, and find TOV, record the transmitted signal power level in 6 MHz and in 120 kHz bandwidth;
- Turn on the interference emission signal. If DTV reception is not possible, increase the DTV signal power level until TOV, record the DTV Tx signal power level in 6 MHz and 120 kHz bandwidth. The difference between the DTV signal power level with and without the interference emission signal is the receiver de-sensitisation.

2. Test at 12m:

- Keep the interference emission signal power unchanged and moves the test point to 6m.
- Repeat the 3m tests.

- The result will be the de-sensitisation at 6m.

3. Test at 24m:

- Keep the interference emission signal power unchanged and moves the test point to 24m,
- Repeat the 3m tests.
- The result will be the de-sensitisation at 24m.

NTSC TEST

- Keep the interference emission signal power unchanged, repeat test at 6m, and 18m with NTSC as the wanted signal.
- For narrowband interference test, the interference emission signal should be transmitted at several in-band frequency locations across 6 MHz channel.
- NTSC signal power is measured as peak average power.

ANNEX 2: LIST OF RECEIVERS

DTV Receiver #	Type
1	Consumer
2	Professional
3	Consumer
4	Consumer
5	Consumer

NTSC Receiver #	Type
1	Consumer
2	Consumer
3	Consumer

ANNEX 3: OFFICE DRY WALL AND PHOTOS OF TEST EQUIPMENT

Figure A3-1: Office dry wall Side A (signal goes through white-board).

Figure A3-2: Office dry wall Side B (signal goes through white-board).

Figure A3-3: UD and DTV/NTSC Transmission Systems.

Figure A3-4: Five DTV Receivers and Reception System Set Up.