In the matter of:

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 Stations	)))))	MB Docket No. 03-185

NOTICE OF PROPOSED RULEMAKING

Adopted: August 6, 2003 **Released: August 29, 2003**

Supplemental Reply Comments of:

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NOTE: These comments are supplemental to the previously submitted reply comments dated 12/26/03.

Gary Sgrignoli hereby submits these *supplemental* comments in response to the Commission's Notice of Proposed Rulemaking (Notice), document FCC-03-198, MB Docket No. 03-185, adopted on August 6, 2003, released on August 29, 2003, and published at 68 FR 55566 on September 26, 2003. This Notice concerns the authorization and deployment of *digital* television translators, boosters, and low power television (LPTV) stations.

1.0 INTRODUCTION:

This document is an addendum to the reply comments of December 26, 2003. New and useful information, pertaining to television translators, boosters, and low power television (LPTV) stations, is contained within this document as well as a companion document that is being submitted concurrently. This companion document **(Ref 1)** is a complete paper entitled "Interference Analysis of Co-Sited DTV and NTSC Translators" authored by Gary Sgrignoli. This paper has been submitted to the IEEE Broadcast Society for publication in IEEE Broadcast Transactions on Broadcasting later this year (September 2004), with all copyright privileges to be transferred over to them upon acceptance of this paper. However, this material is also useful to the FCC in their rulemaking process (MB Docket No. 03-185) on television translators, boosters, and low power television (LPTV), and is hereby submitted for public record as an addendum to the timely submitted reply comments of December 2003. While much of the material from an early draft of this companion paper was included in the original reply comment, the complete paper offers thorough detail and expanded explanations on this supplemental material.

The original reply comments covered a number of relevant technical topics, specifically regarding co-sited DTV and NTSC translators in rural areas, which are just an *extension* of primary full-service stations since translators pass through signals essentially unaltered (other than frequency and amplitude). Their main purpose is to "provide service (outside *or* inside the Grade B contour of a full-service station)" to areas where "direct reception of full-service broadcast stations is unsatisfactory because of distance or intervening terrain obstructions", provided that they have received written consent from the TV station. This addendum will again specifically focus on the *technical* aspects regarding television *translators* rather than on-channel boosters, single-frequency networks, or LPTV stations (although much of the material can be applied to these additional stations as well). Particularly, these comments will address the *technical* issues regarding RF interference protection rules and the methodology that can be employed to provide as much spectrum as possible in *rural* areas of this country.

2.0 BACKGROUND

The upcoming FCC translator rules must be flexible and forward thinking so that spectrum re-packing at the end of the transition period is facilitated. Therefore, new *digital* translator rules should exist with as much flexibility as possible, which is important to such a class of secondary-service stations that are "not restricted to operating on a channel specified in a table of allotments" like full-service stations. Many of the same *types* of rules in place for full-service DTV stations can stay in place for *digital* translators, while new rules can specifically deal with the spectrum efficiency required to provide translator channels during and after the transition. However, it should be noted that unreasonable financial burdens should *not* be placed on translator operators who try to transition from analog to digital.

Spectrum availability presents a great challenge to the digital conversion of TV translators, and efficiently using scarce spectrum is still one of the main challenges. The pace at which these stations begin to operate digitally may depend on the ability of station licensees to secure additional channels. Therefore, careful selection of interference criterion and new analysis methodology should allow both a quick and safe transition to digital television service in the rural areas by efficiently using and re-using the scarce spectrum that is currently available. As stated in the reply comments, "thinking outside the box" will be a necessity in both policy and technical requirements along with an increased cooperative spirit among broadcasters and translator operators.

A key ingredient to overcoming the challenge of spectrum scarcity is to understand the fundamental planning factors that describe real-world analog and digital television receivers. One way to do this is to understand the plethora of previous laboratory measurements performed during the Grand Alliance era by the Advisory Committee on Advanced Television Services (ACATS) at the Advanced Television Test Center (ATTC) in Alexandria, VA from April 19 through July 21, 1995. Twenty-four analog NTSC television receivers were carefully evaluated during this testing process. Likewise, the one-and-only Grand Alliance (GA) DTV prototype receiver was thoroughly tested as well. These results from these laboratory tests were the basis for the FCC's channel allocation planning factors, and therefore this test methodology and data should be thoroughly understood by broadcast engineers. The attached companion paper **(Ref 1)** discusses these topics in great detail.

The companion paper also discusses the distinct advantages of co-siting analog and digital translators, and offers some detailed implementation suggestions. Specifically, transmitted signal power levels are suggested for co-sited multiple translators. For instance, all of the analog NTSC signals should be of equal power. Likewise, all of the DTV signals should be of equal power. The ratio of the peak-sync power of the NTSC signals should be 10 dB *above* the average power of the DTV signals. Then, by co-siting all of these signals and using as many common components as possible (combiners, feedline, directional coupler test point, broadband antenna, tower, etc.), the *relative* field strengths of all these signals can be carefully maintained within a close tolerance over the entire coverage area, thus minimizing interference effects. Close examination of the paper in **Ref 1** will provide much more detail on these matters.

There are two other issues that are addressed in this supplemental reply comment related to a further definition of the two proposed emission masks in the NPRM (which references the original "Sgrignoli paper" **– Ref 2**). The *first* issue at hand is the *separate* definition of the rigid emission mask at frequencies far beyond the first adjacent channels, such as the Global Positioning Satellite (GPS) band above 1 GHz. The two proposed rigid emission masks focus on DTV splatter interference into either an adjacent channel analog NTSC or digital ATSC signal. That is, it focuses on television interference between television signals, within the television band itself. However, the topic of protecting special bands of interest that are outside the normal television frequency band can be treated with *separate*, but related requirements. That is, specific frequencies or frequency bands can and should be treated with the necessary interference protection, but without overburdening the nearby adjacent channel television protection requirements.

The *second* issue for consideration is the use of an *absolute* power requirement for interference protection rather than just a relative requirement. Relative power requirements, such as those described by a rigid emission mask, are always easier to implement, maintain, and regulate. However, absolute power levels radiating out of translator antennas are the actual determining factor in interference into any special frequency bands. By using absolute power as the interference criterion, translator operators can take advantage of the fact that many DTV translators will ultimately use 500 Watts ERP or less in rural areas, with some translators operating as low as 50 Watts ERP (or less). Therefore, any translator harmonic energy output at these critical frequencies will be minimal since the radiated in-band DTV signal power is so low.

These two issues (special handling of critical frequencies and using absolute interference power) were clearly stated in the original Sgrignoli reply comment in December. For example, here are two paragraphs from that December 26, 2003 reply comment (with underlines added here for further emphasis).

> "It should be pointed out that the Sgrignoli emission masks (simple and stringent) referred to in the NPRM focus on the adjacent channel DTV splatter effect on a first adjacent analog or digital signal. Beyond the first adjacent channel, the level of splatter or harmonic energy can be independently regulated by additional means. For instance, at the Global Positioning Satellite (GPS) frequencies beyond 1 GHz, or land mobile frequencies contained within channels 14-20 in the largest 13 cities, or radio astronomy frequencies within UHF channel 27, the rules can specifically state that there must be a required amount of attenuation or a maximum allowable absolute power at the translator's antenna output to protect services in those bands without requiring severe requirements on the energy within the television band. This is similar to what the digital audio broadcast (DAB) rules dictate. This methodology is preferred over requiring everything at the band-edge (and beyond) of the adjacent television channel to be extremely attenuated. This allows for simpler harmonic filters to be implemented for those DTV channels whose harmonics fall within the GPS or radio astronomy bands. While a very steep filter might be needed for a translator that is placed next to a land mobile band in the channel 14-20 region, translator operators would probably avoid these channels. Also, since these land mobile channels exist only in the vicinity of the largest 13 cities, and most translators are out in rural areas, it is unlikely that low-power rural translators would have any interference affect on these land mobile signals."

> "As noted previously, any emission mask that is different from the one used for the full service DTV stations should take care to still require proper attenuation at special frequencies, such as the GPS band and radio navigation satellite service (RNSS) operations at 1559-1610 MHz (L1), 1215-1240 MHz, and 1164-1188 MHz, as well as land mobile (channels 14-20 in the 13 largest cities) and radio astronomy (channel 37). If necessary, any special frequency bands of interest can still have stringent attenuation requirements to protect against 2nd and 3rd harmonics from translators. That is, special frequency bands can be

> determined where the emission mask is required to have significant amounts of attenuation. Except for the CH 14 - CH 20 land mobile band, these bands will not be within the VHF and UHF television band, thereby allowing simple low cost harmonic filters to be used (if needed at all, in addition to the mask filters)."

The use of *absolute* power to define interference power limits in critical frequency bands seems quite appropriate since it is the absolute power radiating out of an antenna that causes the actual interference. The two currently proposed translator emission masks are well defined in the adjacent channels, which then accurately defines the amount of interference into either an adjacent channel NTSC or DTV signal. However, the masks need to be defined for frequencies (far) below and (far) above the first adjacent channels to protect various specific service bands.

On the lower frequency side, there is a possibility of land mobile on some frequencies in the CH 14 - 20 range. These specific frequencies can be defined accordingly with special attenuation requirements in the rigid emission mask, perhaps using the same 500 kHz sub-bands used in the definition of the emission mask for full-service stations. It should be noted again that translator operators will most likely avoid the use of UHF channels that fall adjacent to these land mobile channels, especially when considering the fact that land mobile employment of UHF channels often occur near large metropolitan areas where rural translators rarely operate. Nevertheless, any critical frequencies can be protected with whatever absolute power restrictions are deemed necessary rather than unnecessarily penalizing the transmitter signal output for the entire UHF band.

As an example of this type of mask that uses both a relative and absolute methodology, consider the GPS service as an example of a critical frequency band that requires protection. The three GPS frequency bands are all above 1 GHz (e.g. 1164-1188 MHz, 1215-1240 MHz, and 1559-1610 MHz). There are no UHF channels near or adjacent to these frequencies since the UHF band currently ends at CH 69 (803 MHz) and eventually will end at CH 51 (695 MHz) after the DTV transition is complete. The only way that a UHF transmitter can interfere with these frequencies is with 2nd or 3rd harmonic components that are created in the transmitter's high power amplifier (or a transmission component with some inherent non-linear characteristic). If these components are passed through (or leak through) any subsequent transmission components such as filters, circulators, transmission lines, or antennas, they will be radiated to the surrounding region, and will potentially interfere with GPS equipment if the *absolute* radiated power is not limited in those bands. The emission mask is then defined to protect these other services from excessive interference.

Of course, these harmonic components are proportional to the in-band DTV signal power that is transmitted (radiated) from the antenna. Naturally, very low power transmitters (e.g. < 500 Watts ERP) will inherently radiate much less harmonic energy than very high power transmitters (> 500 kWatts ERP). Therefore, using *absolute* power as an interference criterion is not only proper but also facilitates implementation for low power transmitters.

3.0 DETAILS

As a starting point to determine what amount of *absolute* power is acceptable in critical frequency bands, one can start with the full-service DTV station rules. **Figure 1** illustrates the *relative* rigid emission mask that is currently in force for all full-service DTV stations, regardless of their effective radiate power (ERP). Absolute power is *not* considered in the current FCC rules for full-service television stations; only relative power in the adjacent channels is compared to the in-band DTV signal power (in 6 MHz). Notice that the definition, as stated in the FCC rules, refers to a *measurement* bandwidth of 500 kHz as compared to the *total* in-band DTV power in 6 MHz. Since the maximum allocated DTV signal ERP (in a 6 MHz bandwidth) is presently 1 MWatt, the power in a 500 kHz measurement bandwidth anywhere outside the first adjacent 6 MHz bands is required to be 110 dB below this value. This calculation can be easily performed using the following equation:

$$P_{INT}\text{ (Watts)} = P_{ERP}\text{ (Watts)} / [\ 10^{(110/10)}\ ] = P_{ERP}\text{ (Watts)} / (10^{11}) \qquad \textbf{Eqn (1)}$$

where P_{ERP} is the *total* in-band DTV signal average power (in 6 MHz) and P_{INT} is the *total* interfering power (in a 500 kHz bandwidth). For maximized DTV stations, the average ERP is 1 MW (i.e., 10^6 Watts). Plugging this maximum DTV allocated ERP value into Equation (1) above produces the following result:

$$P_{INT}\text{ (Watts)} = 1\text{ MW} / (10^{11}) = (1 \times 10^6) / (1 \times 10^{11}) = 1 \times 10^{-5}\text{ Watts} = 10\ \mu\text{Watts (in 500 kHz)} \qquad \textbf{Eqn (2)}$$

Therefore, the current FCC rules accept 10 μWatts (in 500 kHz) at any frequency beyond the upper and lower first adjacent channels. If this value is acceptable for protection into other special services from *full* service stations operating at maximum facility, then this amount of interference certainly seems appropriate for DTV translator interference.

Figure 2 illustrates the simple rigid translator emission mask proposed in the Sgrignoli paper. It is a *quadratic* curve describing the mask in the first upper and lower adjacent channels. This emission mask curve starts at -46 dB below the total in-band DTV power (35 dB below the in-band flat-top spectrum) and then decreases to –71 dB at the edge of each first adjacent channel (60 dB below the in-band flat-top spectrum). **Figure 2** also illustrates the stringent rigid translator emission mask proposed in the Sgrignoli paper. It is a *linear* curve describing the mask through the first half of the upper and lower adjacent channels. It starts off with a –47 dB shelf for the first 500 kHz (36 dB below the in-band flat-top), and then decreases linearly to the midpoint in the adjacent channel before it levels off at the –76 dB value (-65 dB below the in-band flat-top).

The goal is to determine how much attenuation is needed for translators in order that they do not radiate into any special frequency bands more than the 10 μWatt (in a 500 kHz bandwidth). However, since translators are inherently low power radiators, they should require less attenuation at these special protected frequencies than a full-service station operating at maximum facility. It so happens that if a translator is radiating 125 Watts ERP and meeting the simple emission mask (including the –71 dB value), then the out-of-band interference is 10 μWatts. Likewise, if a translator is radiating 400 Watts ERP and meeting the stringent emission mask (including the –76 dB value), then the out-of-band interference is also 10 μWatts. However, if the transmitter radiates power *above* 125 Watts ERP with the simple emission mask or above 400 Watts with the stringent emission mask, additional attenuation ("e.g. an "attenuation notch") should be placed in the rigid mask at these protected frequencies. This reflects the necessary attenuation at those specific protected frequencies that is required to limit the amount of interfering power to 10 μWatts per 500 kHz. The amount of attenuation, A (n dB), for any given ERP value can be calculated using the following formula:

$$A \text{ (in dB)} = 10 * \log \left[\text{ERP (Watts)} / 10\ \mu\text{Watts} \right] = 10 * \text{LOG} \left[\text{ERP (Watts)} / 10^{-5} \text{ (Watts)} \right] \qquad \textbf{Eqn (3)}$$

Using Equation (3), the following "de-rating" table can be created to show the protection attenuation value that is needed (compared to the *total* average effective radiated power in 6 MHz) for various low power transmitter ERP values.

Transmitter ERP (Watts)	*Simple* Mask Attenuation (dB)	*Stringent* Mask Attenuation (dB)
15,000	92	92
10,000	90	90
5,000	87	87
1,000	80	80
500	77	77
400	76	**76**
250	73	**76**
125	**71**	**76**
100	**71**	**76**
50	**71**	**76**

Note that the attenuation is limited ("capped") to the proposed rigid emission mask values outside the first adjacent channel, i.e., to 71 dB for the simple mask and 76 dB for the stringent mask. Therefore, if the transmitted ERP is below 125 Watts for the simple mask or below 400 Watts for the stringent mask, the amount of attenuation is limited to the original mask's maximum level of attenuation.

Figure 3 is an overlay of the current FCC emission mask for a 1 MWatt ERP full-service station and a proposed *simple* emission mask for a 125 Watt ERP translator station. Note that *both* of these masks provide for a 10-μWatt interference level anywhere outside the DTV channel and its upper and lower first adjacent channels. However, the translator is using the simple emission mask, which has 71 dB of attenuation outside the first adjacent channels in any 500 kHz sub-band as compared to the total in-band DTV power while the full-power 1 MWatt station requires 110-dB of attenuation. The 39-dB attenuation difference in the mask attenuation is due to the 39-dB difference in the *absolute* in-band DTV ERP values. That is, 125 Watts is 39 dB below 1 MWatt. Therefore, using *absolute* ERP powers as the protection methodology for special frequency bands of interest will provide the same amount of interference protection as the full-service stations, but with much less effort and expense to translator operators.

Figure 4 is an overlay of the current FCC emission mask for a 1 MWatt ERP full-service station and a proposed *stringent* emission mask for a 400 Watt ERP translator station. Note that *both* of these masks provide for a 10-μWatt interference level anywhere outside the DTV channel and its upper and lower first adjacent channels. However, the translator is using the stringent emission mask, which has 76 dB of attenuation outside the first adjacent channels in any 500 kHz sub-band as compared to the total in-band DTV power while the full-power 1 MWatt station requires 110-dB of attenuation. The 34-dB attenuation difference in the mask attenuation is due to the 34-dB difference in the *absolute* in-band DTV ERP values. That is, 400 Watts is 34 dB below 1 MWatt. Therefore, once again, using *absolute* ERP powers as the protection methodology for special frequency bands of interest will provide the same amount of interference protection as the full-service stations, but with much less effort and expense to translator operators.

Therefore, if the FCC rules were written only for limited translator ERP values that create 10 μWatts (in 500 kHz) interference levels outside the first adjacent channels, the simple mask would allow a 125 Watts maximum ERP, and the stringent mask would allow a 400 Watts maximum ERP.

It should be noted that the proposal described in these supplemental comments still maintains that a relative emission mask be used for the first adjacent channels and all of the remaining *non*-critical frequencies within the television bands (VHF and UHF). Only absolute powers are considered when special critical frequencies are being addressed. The only exception might be when a translator operator cannot comply with the first adjacent channel "shelf" value (46 dB in the simple mask and 47 dB in the stringent mask). It has been suggested in the NPRM comments and reply comments that translator in this case can receive a "waiver" if the transmitter in-band DTV power is lowered (i.e., de-rated) by the *same* amount (in dB) that the close-in shelves "miss" the rigid emission mask target values. If the shape of the splatter is assumed to remain the same as the in-band DTV power is lowered, then the amount of absolute total (integrated) adjacent splatter power remains the same as it is in the case where the translator splatter meets the rigid emission mask specified values. The coverage area may suffer a little under these conditions, but it is an incentive for the translator operator to improve the splatter conditions at some future time. This also adds a sense of "fairness" to the process among all the translator operators (especially to those who do meet the emission mask everywhere), and it prepares these translator operators for future first adjacent analog or digital "neighbors."

Also, this proposal suggests that all translators using the *simple* mask with an ERP of 125 Watts or less use the same minimum level of attenuation (71 dB) for all frequencies outside the first adjacent channels. It also suggests that all translators using *more* than 125 Watts can determine the additional attenuation by using the de-rating formula in Equation (3) for the special protection bands under consideration. The proposal also suggests that all translators using the *stringent* mask with an ERP of 400 Watts or less use the same minimum level of attenuation (76 dB) for all frequencies outside the first adjacent channels. It also suggests that all translators using *more* than 400 Watts can determine the additional attenuation by using the de-rating formula in Equation (3) for the special protection bands under consideration.

Figure 5 shows the *simple* emission mask for several DTV ERP values, starting at 125 Watts through the proposed maximum amount of 15 kW for translators (as well as LPTV and booster stations). In all these cases, the protected band has only 10 μWatts (in 500 kHz) of interference. Note that the *relative* nature of the mask remains intact in the television band regardless of the translator ERP, while the special protected frequencies are based on the *absolute* level of the transmitted power. A generic protected frequency band is identified far above the DTV channel. Note that for a 125-Watt ERP value, the required interference power attenuation for a 10-μWatt interference level happens to occur at the same *relative* -71 dB level as the extended simple emission mask. In theory, if the DTV translator is less than 125 Watts ERP, less attenuation would be needed to protect these special frequencies. However, there is no reason to make the attenuation outside the UHF band any less than the currently proposed simple mask limiting factor (-71 dB), especially in light of the fact that this 71-dB attenuation level is easily obtainable with typical and affordable components.

Figure 6 shows the *stringent* emission mask for several DTV ERP values, starting at 400 Watts through the proposed maximum amount of 15 kW for translators (as well as LPTV and booster stations). In all these cases, the protected band has only 10 μWatts (in 500 kHz) of interference. Again, the *relative* nature of the mask remains intact in the television band regardless of the translator ERP, while the special protected frequencies are based on the *absolute* level of the transmitted power. A generic protected frequency band is identified far above the DTV channel. Note that for a 400-Watt ERP value, the required interference power attenuation for a 10-μWatt interference level happens to occur at the same *relative* -76 dB level as the extended stringent emission mask. In theory, if the DTV translator is less than 400 Watts ERP, less attenuation would be needed to protect these special frequencies. Just as with the simple mask, there is no reason to make the attenuation outside the UHF band any less than the currently proposed stringent mask limiting factor (-76 dB), especially in light of the fact that this 76-dB attenuation level is easily obtainable with typical and affordable components.

In the real-world implementation of DTV translators, the important issue will be to determine how much, if any, harmonic energy falls within protected bands, such as those used for GPS. Of course, the total energy depends upon a number of transmission components in the translator system. For example, the following parameters describe the level of interference into protected bands:

1) The amount of 2nd and 3rd harmonic energy generated by the transmitter (due to non-linearities in the high power amp)

2) The amount filtered out by any isolator (circulators)

3) The amount *generated* by any isolators (circulators) due to the non-linear magnetic core

4) The amount of attenuation in the emission mask filter at the harmonic frequencies (including any self-resonant effects)

5) The amount of loss in the transmission line at the harmonic frequencies

6) The amount of gain in the antenna at the harmonic frequencies

The parameters listed above need to be quantified for typical, reasonably priced components in order to determine that the absolute power requirements in the restricted bands are acceptable. However, early measurements on typical translator hardware components are providing very encouraging results for straightforward implementation of translators that will easily meet the above proposed emission masks with special frequency band "attenuation notches" based on the 10-μWatt *absolute* power interference limit.

One final note can be made regarding the specific GPS frequencies. The 2^{nd} and 3^{rd} harmonics of certain UHF channels will fall within the known three GPS bands. It is important for translator operators to be aware of these channels, even though it is believed that harmonic control of splatter interference into these bands is straightforward and relatively easy to achieve with reasonably priced components. The following table summarizes the channels that *could* have harmonic content that falls within these protected frequencies.

TABLE 1

GPS Bands			**2^{ND} Harmonic Interference from UHF Band**					**3^{RD} Harmonic Interference from UHF Band**				
F_{LOW} (MHz)	F_{HIGH} (MHz)	BW (MHz)	F_{LOW} (MHz)	F_{HIGH} (MHz)	BW (MHz)	TV CHs (*)	Note (*)	F_{LOW} (MHz)	F_{HIGH} (MHz)	BW (MHz)	TV CHs (*)	Note (*)
1164	**1188**	**24.0**	**582.0**	**594.0**	**12.0**	---	---	**388.0**	**396.0**	**8.0**	---	---
			578	584	6.0	32	1	---	---	---	---	---
			584	590	6.0	33	---	---	---	---	---	---
			590	596	6.0	34	1	---	---	---	---	---
1215	**1240**	**25.0**	**607.5**	**620.0**	**12.5**	---	---	**405.0**	**413.3**	**8.3**	---	---
			602	608	6.0	36	2	---	----	---	---	---
			608	614	6.0	37	4	---	---	---	---	---
			614	620	6.0	38	---	---	---	---	---	---
1559	**1610**	**51.0**	**779.5**	**805.0**	**25.5**	---	---	**519.6**	**536.6**	**17.0**	---	---
			776	782	6.0	65	1, 3	518	524	6.0	22	1
			782	788	6.0	66	3	524	530	6.0	23	---
			788	794	6.0	67	3	530	536	6.0	24	---
			794	800	6.0	68	3	536	542	6.0	25	2
			800	803	6.0	69	3	---	---	---	---	---

Note 1: Partial section of DTV spectrum band falls within the harmonic interference frequency band

Note 2: Very small (*insignificant*) portion (< 600 kHz) of the DTV spectrum band falls within the harmonic interference frequency band

Note 3: These channels are out-of-core (i.e., not within CH 2-51) and therefore should not be used for primary DTV service after the transition

Note 4: CH 37 is not allocated by the FCC due to its use in radio astronomy

Table 1 shows that during the transition (i.e., when analog NTSC signals still on the air), there are 11 UHF channels that can have all or part of their 2^{nd} harmonics falling in one of the three GPS bands. Only 4 UHF channels can have all or part of their 3^{rd} harmonics falling in these protected bands. That is, a total of 15 channels out of a total of 56 UHF channels (during the transition) can interfere with one of the GPS bands. This, of course, doesn't count CH 37, which is not allocated by the FCC since it is reserved for radio astronomy use. However, two of these channels (CH 25 and 36) are insignificant harmonic contributors since only about 600 kHz (10%) of the DTV channel is a possible interferer. On the other hand, when the transition ends and CH 52 – CH 69 is not available for broadcast television (except where exceptions are made or spectrum is purchased), only 9 UHF channels will be possible 2^{nd} or 3^{rd} harmonic interferers (again, two of these are only minor contributors). While these channels will produce possible harmonic interference, these channels can still be used since significant harmonic rejection in translators should be easy and affordable to achieve. Therefore, this appears to be a very workable situation for DTV translator operators.

4.0 SUMMARY AND CONCLUSION

There are four proposals described in this supplemental reply comment:

(1) Use *co-sited* analog and digital translators for controlled relative field strengths throughout the coverage area

(2) Use an NTSC-to-DTV transmission power ratio of *10 dB* to avoid interference among the co-sited signals.

(3) Use a 10-μWatt *absolute* power limitation methodology for protection of special frequency bands

(4) Treat special protected frequency bands *separately* by modifying the emission mask specifically at those frequencies for the desired *absolute* interference power limit.

The two proposed rigid emission masks are both workable and affordable, and fit in quite well with the four proposals summarized above. These concepts give the translator operators some flexibility, and they offer a benefit to *low* power transmitter operations. Since rural translators typically radiate low (< 50 Watts ERP) to moderate (< 500 Watts ERP) power to cover large open areas, minimal interference will be experienced in these special protection frequency bands that are often outside the television band. Yet, this can be accomplished without excessively being a financial burden to the translator operators. The two emission masks as defined in the Sgrignoli paper can still be utilized as they now exist (i.e., in a relative sense) to describe the protection needed in other parts of the television band, while the special protected frequencies would be described by the absolute power method. It is believed that these two new principals, coupled with the use of co-sited analog and digital translators, are crucial to quickly and successfully transitioning to digital television in rural areas. These principles can even be used in rules for full-service DTV stations after the transition period has ended and the DTV signals are repacked into the core spectrum.

Once again, the translator industry looks forward to quick action by the FCC in order to begin the DTV transition in the rural areas. The DTV transition in rural areas of this country, where spectrum crowding is *not* as severe as in major urban centers, should not be impeded. It has been shown both in theory and by experiment in the field that carefully engineered *co-sited* translators can provide many channels of DTV (and clean NTSC as well) to viewers who have become accustomed to having little and/or poor-quality local television. As always, more DTV education (conferences, published papers, seminars, etc.) in the broadcast industry will help to facilitate the successful transition from analog to digital in all areas of the country.

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5.0 REFERENCES:

(1) "Interference Analysis of Co-Sited DTV and NTSC Translators", Gary Sgrignoli, *submitted* to IEEE Broadcast Technology Society for publication and copyright in September 2004.

(2) "DTV Repeater Emission Mask Analysis", by Gary Sgrignoli, IEEE Transactions on Broadcasting, Vol. 49, Number 1, March 2003.

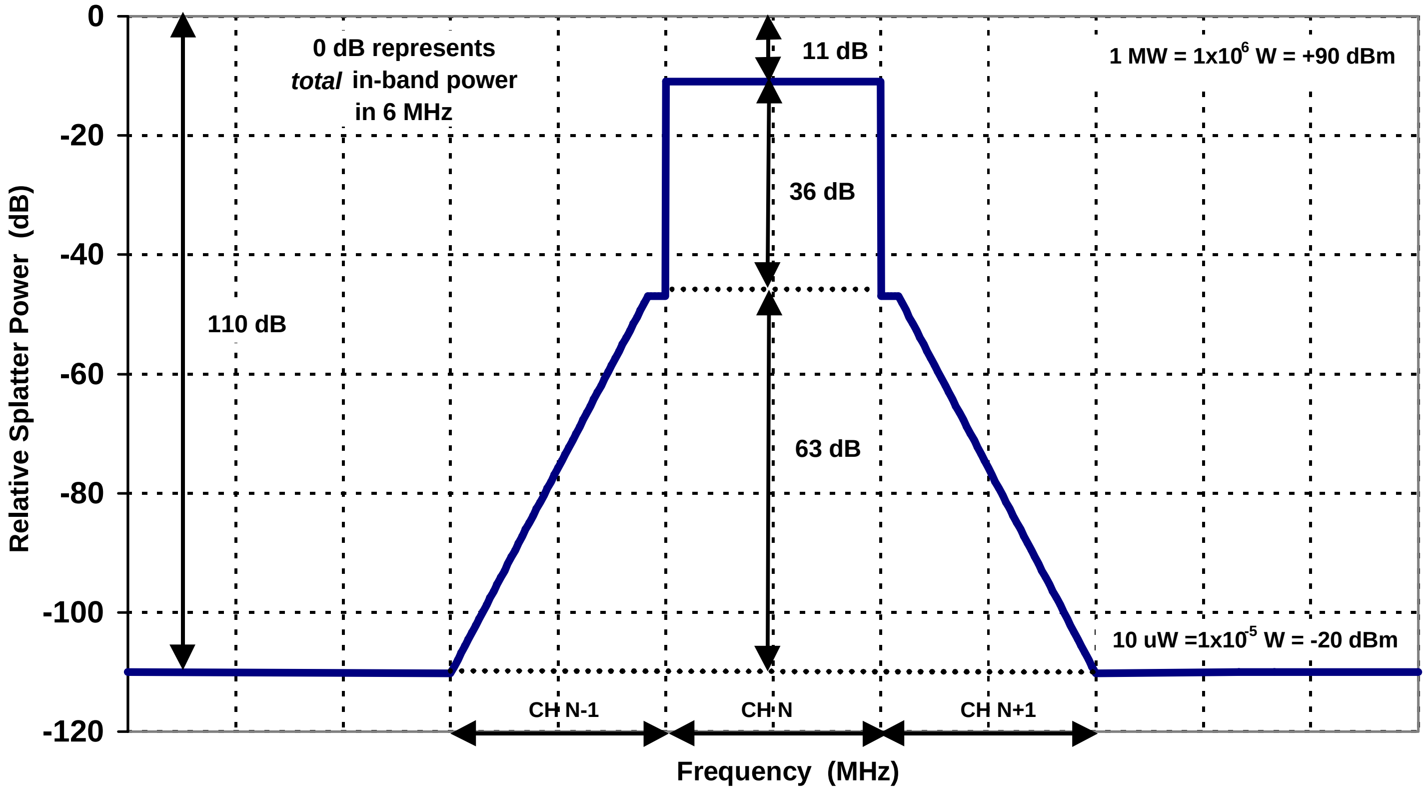

Figure 1 Current FCC emission mask for maximized (1 MW) full-service DTV station.

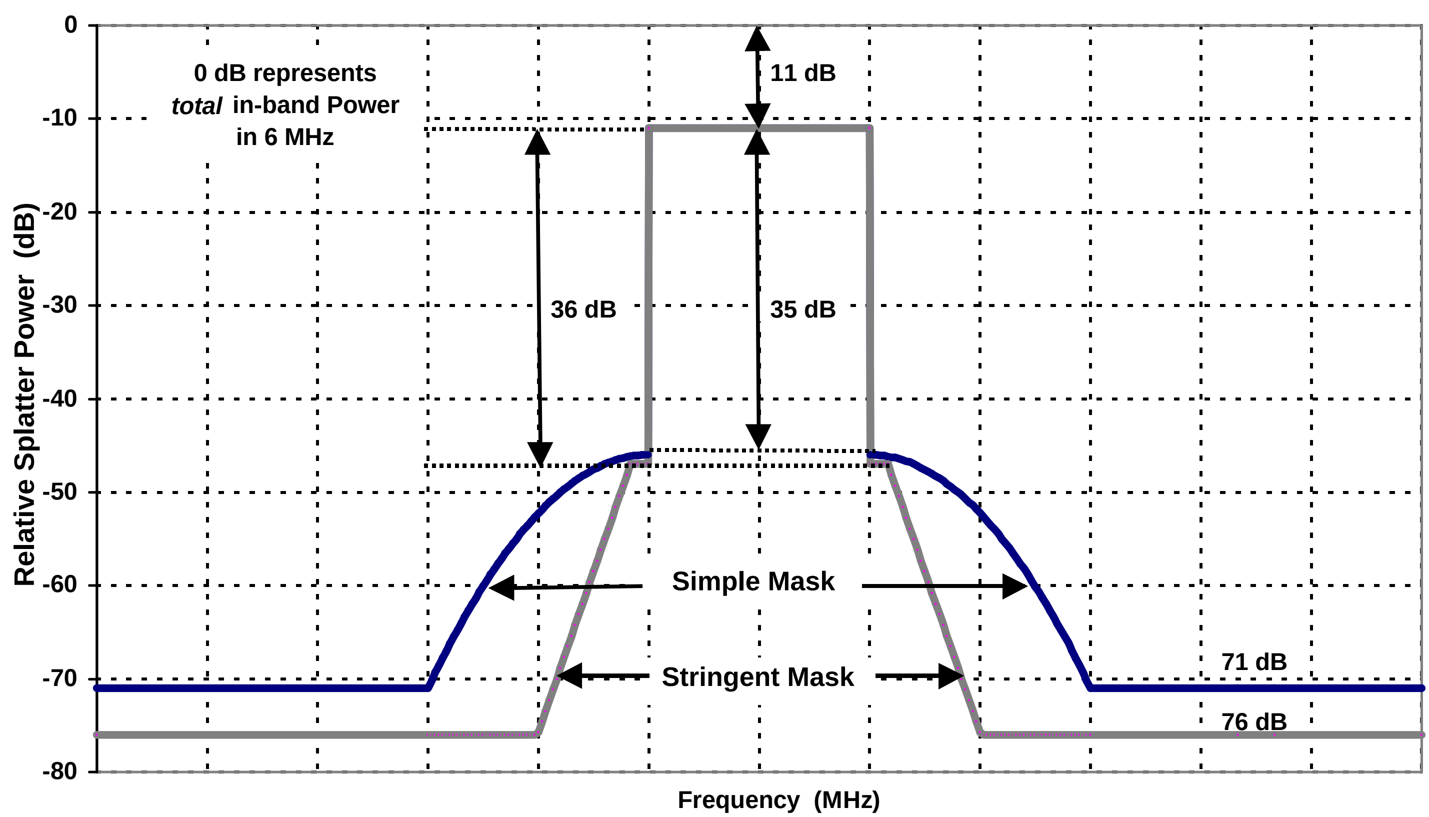

Figure 2 Proposed simple and stringent emission masks

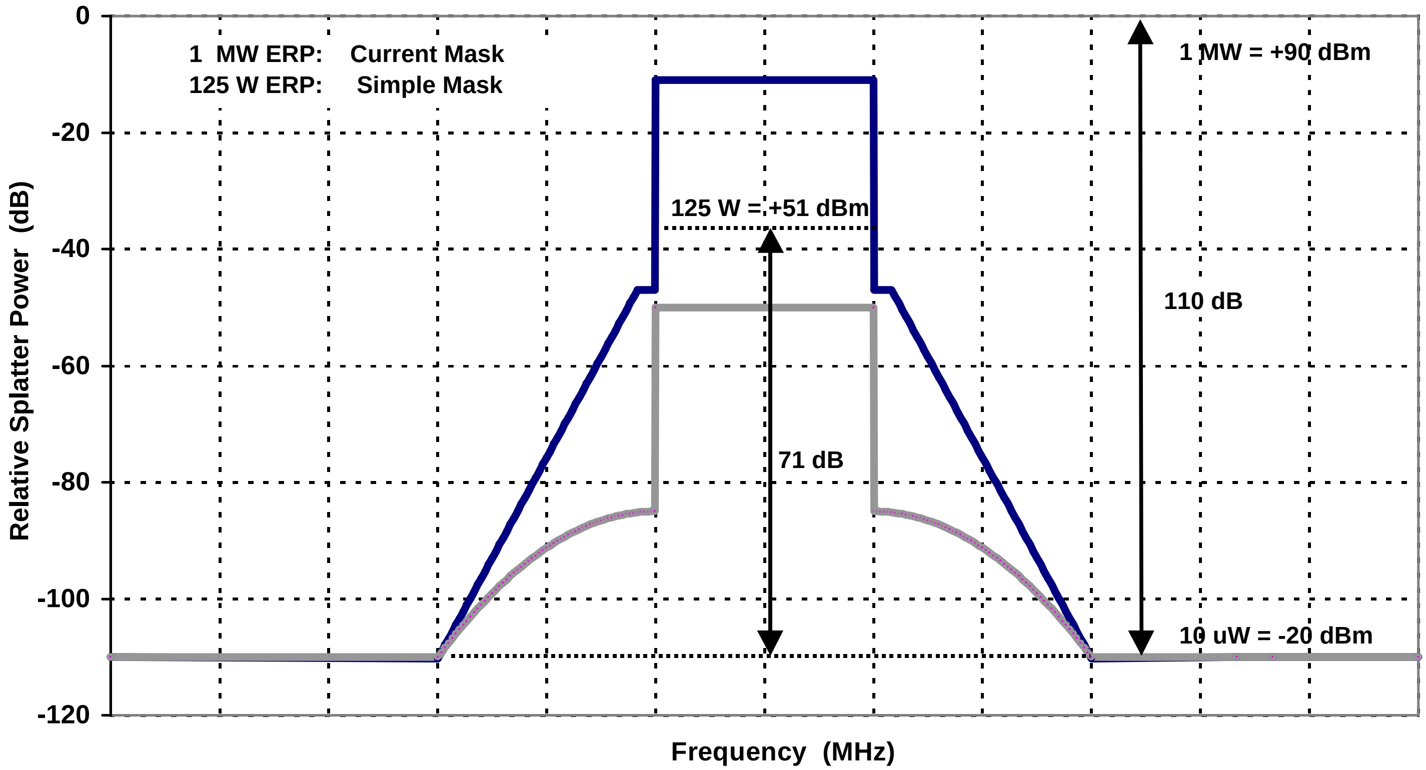

Figure 3 Comparison of current emission mask and the simple emission mask with *equal* 10 μWatt interference power

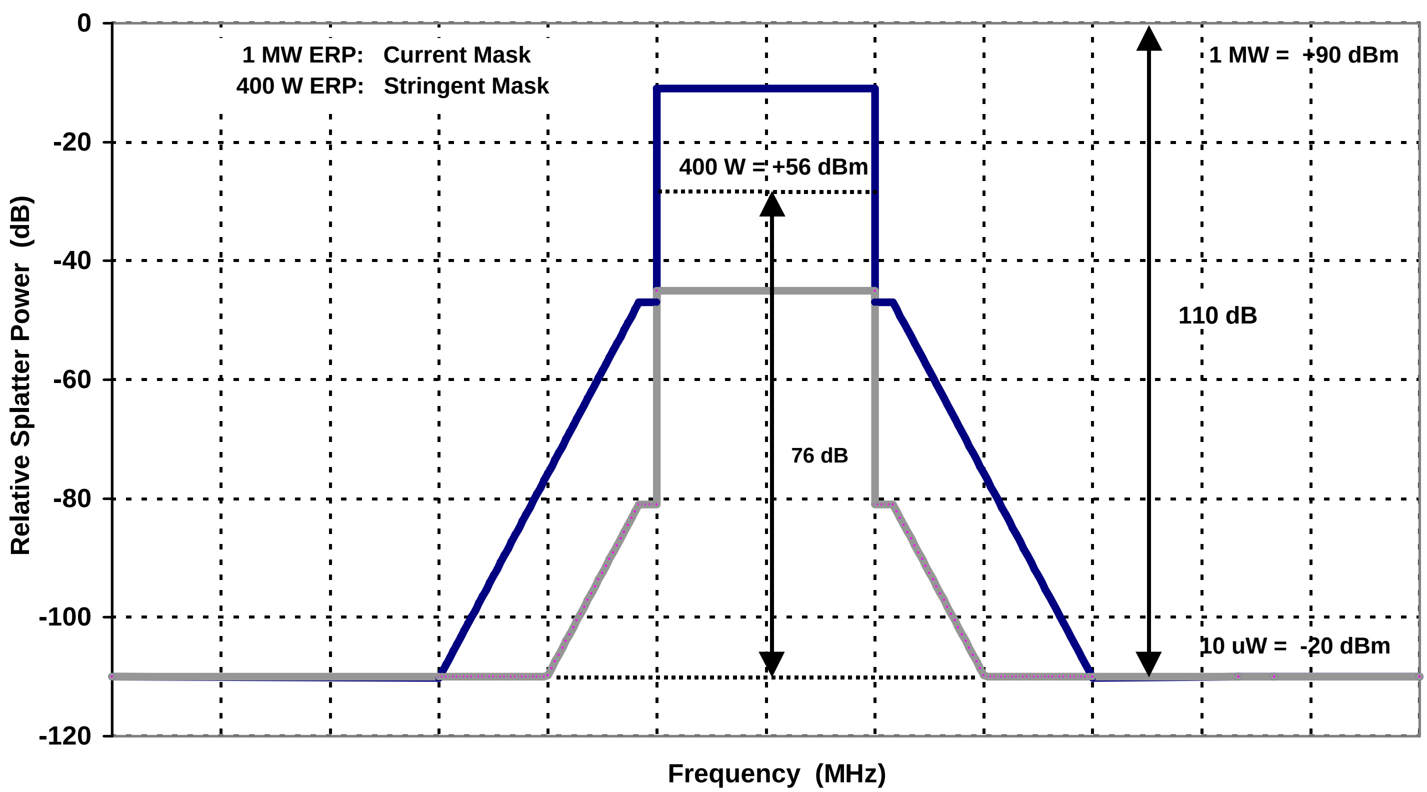

Figure 4 Comparison of current emission mask and the stringent emission mask with *equal* 10 μWatt interference power

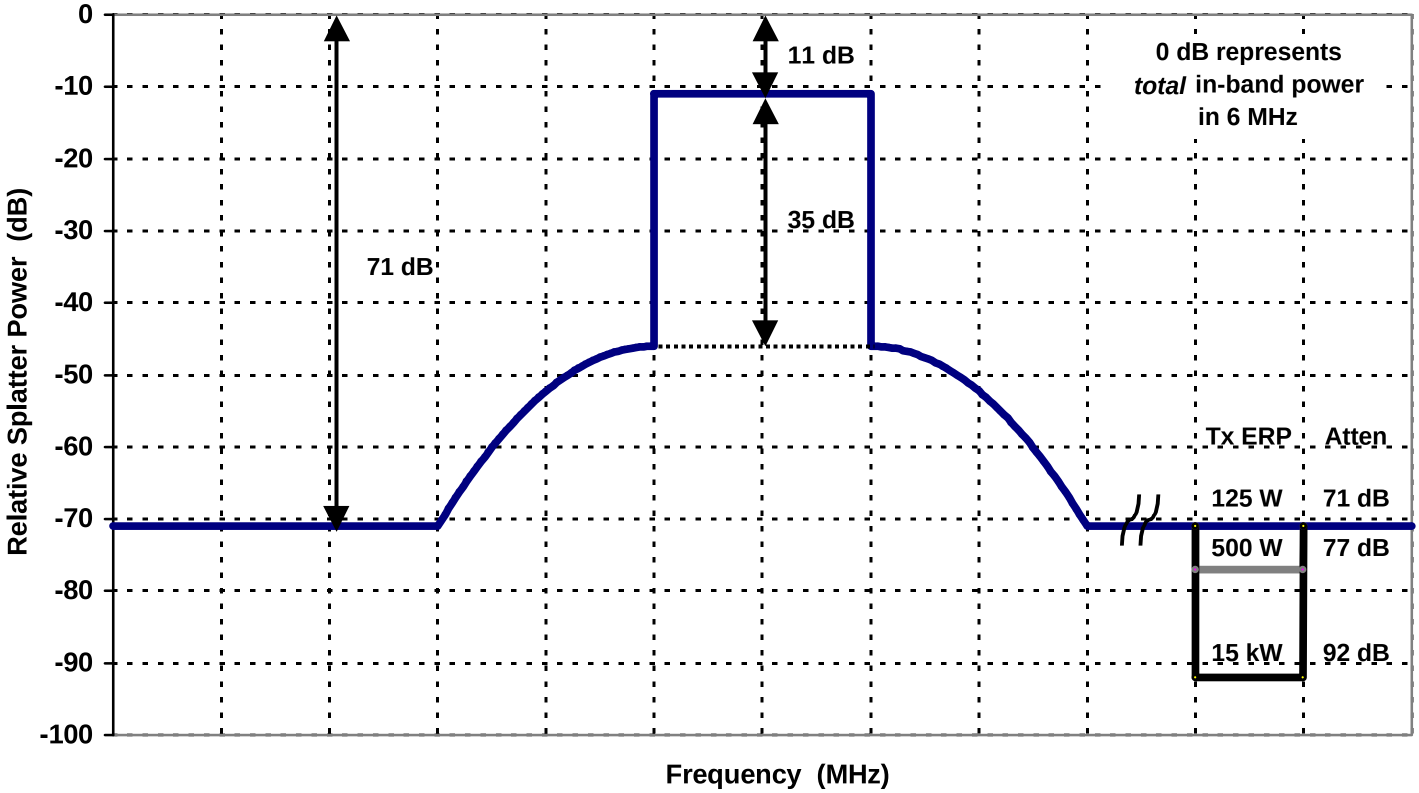

Figure 5 Simple emission mask with "notch attenuation" at special protection frequencies

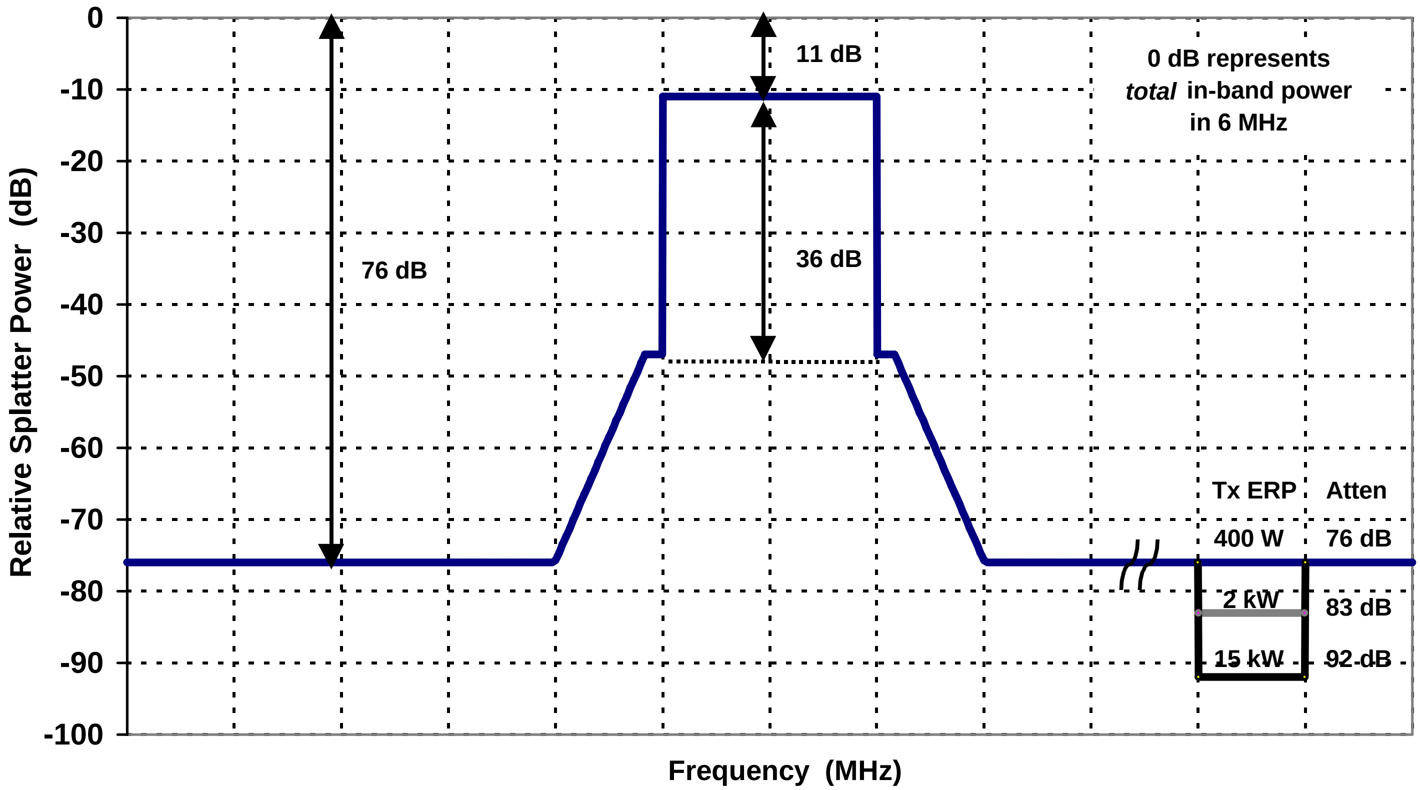

Figure 6 Stringent emission mask with "notch attenuation" at special protection frequencies