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Dear David,

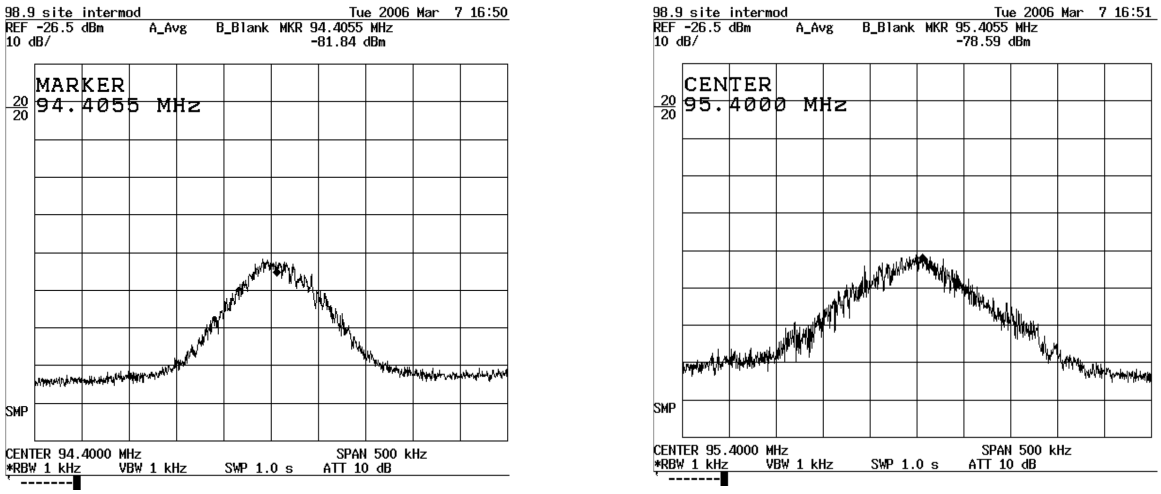
I am in receipt of the responses to our 2007 FM broadcasting survey report ("Report"). I am impressed by the gravity and respectfulness with which most respondents have made their comments. Also, I am grateful that all parties have been nothing but hospitable during our visits to Grand Cayman. I respond to the comments by document author:

Paramount Media

I appreciate Paramount's concern that this is apparently the second time their 94.9 MHz exciter has gone back to the factory and no fault reportedly has been found. Troubleshooting broadcast apparatus can be frustrating at times when a fault cannot be found. There is no question that the spurs around 94.9 are generated within the 94.9 transmission system.

Figures 1 and 2 are images of the output of the 94.9 transmitter taken of the spurs that are symmetrical about 94.9. They were taken in 2006 and were sampled from the transmitter tap of the 94.9 transmitter. Referring to my 2006 field notes, I "tested the exciter tap – same problem seen." The Armstrong exciter has an RF Test port for this purpose. This confirms my recollection that I tested the exciter output in 2006 in the presence of Mr. Bremmer and found the flaw there. This was the basis of my conclusion in our 2006 report that the source of the spurs was the exciter.

My 2006 data also shows that a similar test of the adjacent 98.9 transmitter output tap revealed a low-level presence of both 94.9 and its spurs. This is a common occurrence when one FM antenna on a tower picks up the signals from another FM antenna on the tower. This indicates that the 98.9 transmitter was not generating the spurs, but simply receiving them from the 94.9 antenna. In addition, because the spurs were visible in the 94.9 exciter output, they must be generated in the 94.9 transmission system; the power amplifier of the 94.9 transmitter isolates the exciter from outside emissions picked up by the broadcast antenna.



Figures 1 and 2
Spurious Emissions of 94.9 Transmitter at 94.4 and 95.4
Top of Display is Carrier Reference Level
Taken from Transmitter Tap in 2006

Since 2006, the spurs around 94.9 have remained. They were visible at many locations on the island not only to Broadcast Signal Lab in 2006 and 2007, but also to ICTA's spectrum auditor, Aerosystems International, in late 2006. In the field, and at the 94.9 exciter tap, the relationship between the spurs and the 94.9 carrier were the same, at about -52 dBc. This suggests they all come from the same source.

Also, to demonstrate the spurs are not artifacts of instrumentation overload, Figure 3 is a 2007 spectrum plot from site #7, John McLean Drive. This site is in excess of ten miles from any broadcast facilities, yet the spurs are still evident straddling 94.9.

The images from 2005 and from 2007 suggest there has been a progressive increase in the spur levels. Figure 4 shows that, even in 2005, 94.9 had the spurious emissions at its temporary facility in George Town. Then they were at a much lower level than in 2006 – about 70 dB below the carrier level. Paramount can confirm whether the same equipment was moved to the Avcom tower in Newlands.

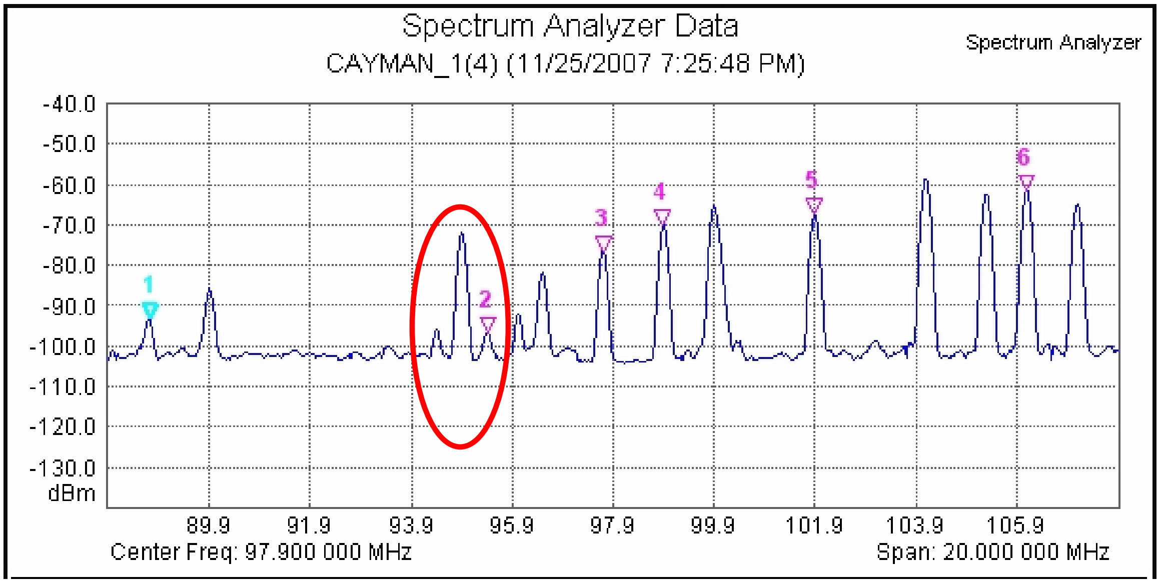


Figure 3

Spectrum Taken at John McLean Drive, East End, 2007

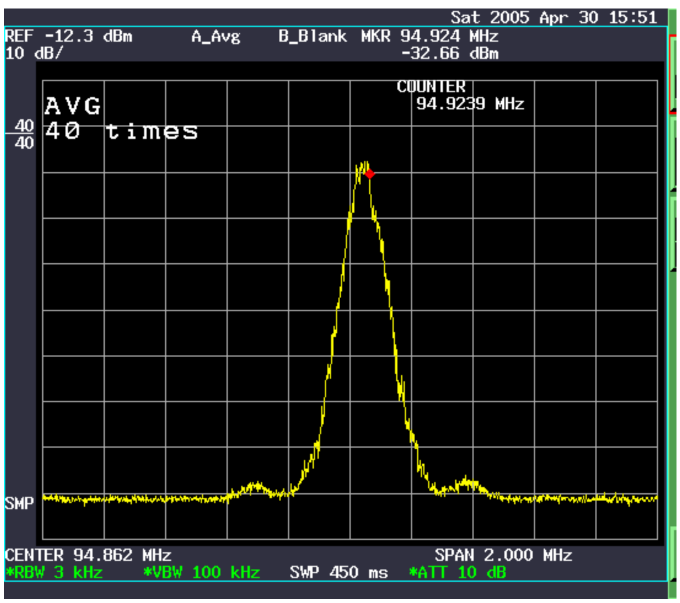


Figure 4

94.9 with Spurious Emissions at 94.4 and 95.4 in 2005

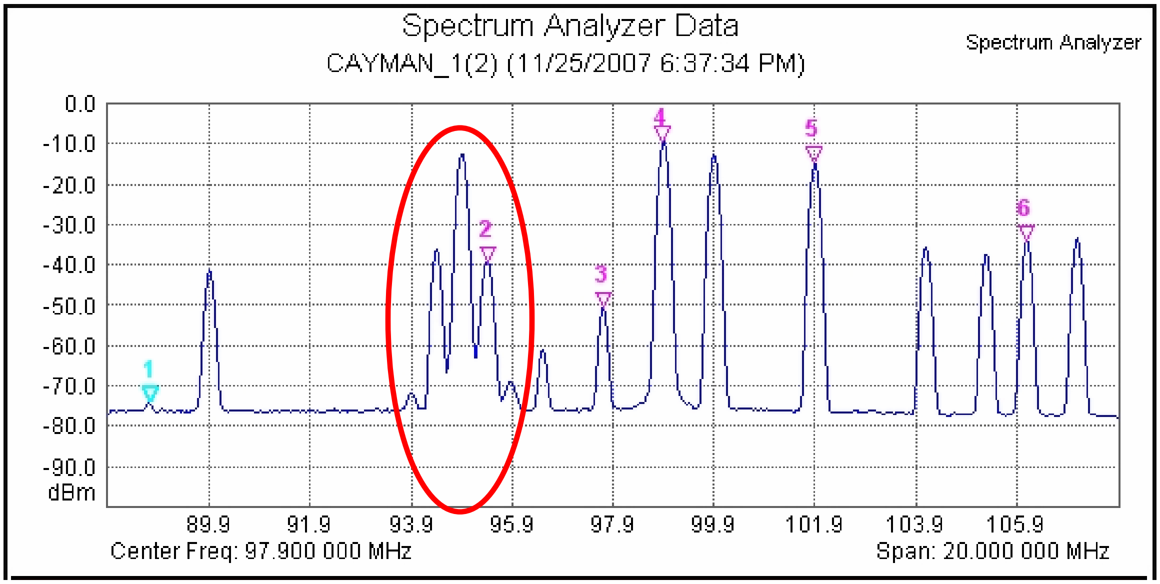


Figure 5

94.9 and Its Spurious Emissions Captured in a Sweep of the FM Spectrum

In Newlands, 2007 Survey

In 2007, the spurs straddling 94.9 are higher than in 2006 – at about 25 dB below the carrier power. Even though a bandpass filter was installed on 94.9 after the 2006 measurement, it apparently was broad enough to pass the spurs in 2007. Figure 5 shows 94.9 taken off the air in Newlands left of marker number 2. Marker 2 indicates the position of the 95.4 spur. Its complement is to the left of 94.9 at 94.4.

It is interesting to note that there are secondary spurs now appearing in 2007 outside the 94.4 and 95.4 spurs. These are the low-level "bumps" at 93.9 and 95.9. This illustrates that there is a pattern in which the spurs are symmetrically spaced at 500 kHz intervals about 94.9, suggesting there is a 500 kHz component to the spur generation mechanism. Such components can be the result of leakage of a power supply switching frequency, a frequency synthesis frequency, or a parasitic oscillation into the modulated signal. These spurs are intermodulation products, but the intermodulation is with an internally generated frequency within the exciter or transmitter. The only way to obtain such intermodulation products so symmetrically about the center frequency is from within the transmission equipment. No outside source can explain the facts presented here. Mathematically, $f1 \pm f2$ = 2nd order products, where f1 is 94.9 MHz and f2 is a 0.5 MHz internal oscillation.

If the 94.9 exciter indeed is functioning properly at the factory, then the next step I would take in troubleshooting would be to suspect that it is either a) a problem that is induced only with thermal stress not available on an air conditioned test bench or b) the interaction between transmitter and exciter that is provoking the problem.

> a) An integrated circuit, amplifier, or capacitor could be progressively failing and be increasingly susceptible to thermal stress. This condition is often not observed on a test bench unless the device is deliberately subjected to thermal stress under test. It is not uncommon for an exciter to have its capacitors fail over time, particularly in hot environments, producing either leakage from the switching power supply or parasitics within an amplification stage. Field replacement of the significant capacitors in the unit could be performed by a competent technician with advice from the manufacturer.
>
> b) At the factory there was most certainly an ideal resistive load placed on the exciter for testing. If the load presented by the transmitter to the exciter is not ideal, there is a possibility that this mismatch provokes exciter misbehavior. This is a less likely scenario, especially if the reflected power between transmitter and exciter is within norms.

While I do not believe any further testing is necessary to condemn the 94.9 exciter, one final test could be performed to isolate the exciter from the transmitter. Modern exciters are typically frequency agile. The two stations' exciters could be swapped to see if the problem follows the exciter or stays with the transmitter. The spurs are two and a half channels from the 94.9 carrier. If there is no spectrum analyzer available, the spurs are at sufficient levels that a reasonably selective receiver can detect them. The receiver may sound different with the spur present than with it absent. The receiver should be a distance from the transmitter site, such as about a mile away, to minimize overload while still maintaining as high a spur level as possible. Alternatively, the ICTA digital spectrum analyzer may be able to detect the spurs, with some experimentation on settings.

While I recognize that it is not our responsibility to repair or adjust licensees' facilities, I am happy to offer advice. My advice should not be relied upon as a substitute for professional on-site support and is not guaranteed.

In summary, the spurious emissions straddling 94.9 are generated at the 94.9 transmission facility. They have been there a long time. They appear to be getting worse.

Radio Cayman

Radio Cayman acknowledges it "will also work to address the issue of interference, which is being caused by 89.9 on the frequency used for aeronautical communications." In fact, 89.9 is not the cause of the emissions on the aeronautical frequencies. Rather, the transmitters that have not protected themselves from 89.9 ingress are actively causing the emissions on the aeronautical frequencies. The intermodulation mathematics bears this out. Third-order products occur with the harmonic of one transmitter mixing with the fundamental of the ingressing signal:

$$2f1 - f2 = IM_3$$

where f1 is a station such as 104.1 and f2 is 89.9

The harmonic of 104.1 is present within the 104.1 power amplifier and mixes with the 89.9 signal traveling the wrong way into the 104.1 transmitter output. Typically, the party whose transmitter is actively generating the interference takes responsibility for installing proper filtering to protect its transmitter from ingress of local signals.

dms Broadcasting

dms suggests some of our 2007 observations are "anecdotal" and deserve further testing before remediation is initiated. I agree that some of my observations are based on the information available to me at the time of the survey, which often does not include sampling from transmitter taps. I welcome more problem-specific testing to confirm my findings. Such testing should not be a substitute for prompt remedial action. My observations are largely based on an understanding of interference-generating mechanisms, and should be a reliable guide for further analysis and action.

dms states that we have "lumped" three stations in Georgetown into a single class when evaluating potential blanketing related effects. Indeed there is a 3 dB difference between the power of 97.7 and 96.5 (2 kW versus 1 kW transmitter power output). However in terms of effects in the field, this is a small distinction. The FCC raw calculation of the blanketing radius is based on the square root of the power, resulting in only a 30% decrease in radius when the power is cut in half. In addition the "skewed bowtie" pattern of the 96.5 antenna array may behave in that fashion in the horizontal plane of the array (toward the horizon) but close-in, off-plane behavior of the antennas does not necessarily follow the horizontal pattern. More analysis would be required. Also, specifics on the azimuths of the antennas would be necessary to more precisely map signal levels in the area of the station.

Regardless of the foregoing, the blanketing radius employed by the FCC is inherently a gross estimation, as it is simply based on the effective radiated power of the station, which incorporates maximum gain of a directional antenna. There is no particular rigorous definition of blanketing interference of which I am aware. Engineers have their own interpretations of what is and what is not a blanketing phenomenon. Blanketing does not simply make radios go dead on all frequencies. Blanketing can desensitize radios to weaker signals; it can induce radios to internally generate intermodulation products that interfere with reception of some signals; and it can cause a radio to effectively mute on particular channels.

A blanketing area is a rather grossly defined phenomenon for other reasons as well. As is well known, various models of radio respond quite differently to undesired radio signals. Signal strength alone is not the determinant of how a radio might be prevented from acquiring a desired signal. The combinations of the radio's design, other signals' received power levels, and their frequencies contribute to obstructing reception of some desired signals and possibly not others. The blanketing radius, then, is a blunt instrument for assessing potentially excessive reception problems due to nearby stations. It my be a case of gilding the lily to attempt to more narrowly define a station's blanketing area using antenna patterns and receiver statistics rather than using the coarse radius tool as a guide.

Also, in the course of assessing blanketing potential from the George Town Three stations, one must keep in mind the ICTA expectation that stations cover the entire island. If power increases are necessary to achieve full coverage from George Town, then our blanketing estimates are quite conservative. Should the baseline for evaluation of stations be only what they are doing now, with lesser power levels than necessary to serve the island, or with stations anticipated to be operating as full-service facilities? Does permitting a station to stay in George Town at less than optimal power meet public policy objectives?

dms also suggests that 97.7 is as likely to be producing the 93.5 spur as is 96.5. An understanding of the intermodulation mechanisms in transmitters helps point the finger at the 96.5 transmitter. The second harmonic of 96.5 would be interacting with the fundamental of 97.7 to create the spur. The second harmonic of a station is prominent within its own transmitter, not other transmitters picking it up (as also explained in the example discussed above with respect to 89.9). It is easily and reliably inferred that the station whose second harmonic is involved in the intermodulation product is the source of the intermodulation. Of course, I agree that it is prudent to look more closely at the problem to confirm the diagnosis.

dms also suggests that in Northward, the “out of whack vertical pattern” of 89.9 is a significant contributing factor to the generation products in the aeronautical band. This is speculation laid upon my informed speculative assessment of the 89.9 coverage.[1] I agree that the present combiner design and antenna positioning afford some modest isolation between transmitters on the combiner. However, in addition to the spurious emissions on the aeronautical band, I observed and reported intermodulation products between some of the transmitters on the combiner. I do not see that 89.9 has any responsibility to protect the four other stations at the site from its emissions. As discussed above, it is the second harmonics of the four upper stations that interact with the ingress of 89.9 to create spurs in the aeronautical band. The second harmonics are resident in the upper four transmitters. These four stations should cooperate in devising an effective filtration scheme.

dms disagrees that “the George Town three should be forced to move based on complaints of a competitor...” This is a public policy decision that we have no stake in. We are interpreting the island-wide coverage objective stated in the licences as a key component of the current public policy for the evolution of the FM band over time. As well, we were first called in to evaluate interference issues relating to the operation of several stations. A balanced, equitable FM siting scheme that maximizes the ability of the general population to have full choice of programming on the FM band seems to be a reasonable objective. In addition to island-wide coverage serving this objective, minimized interference potential is also desirable.

We did not measure modulation of the FM stations. The occupied bandwidth of the stations does not seem to be excessive, based on the spectrum analysis. Modulation regulation helps create a level playing field that enables a more consistent listener experience of the FM band. However,

[1] The point about verifying my findings is well-taken. dms might generously share its island-wide coverage assessment with Radio Cayman to help them evaluate the performance of the 89.9 antenna in comparison with the 105.3 antenna.

stations whose formats and budgets lend themselves to heavy audio processing will tend to sound louder than others, even when all stations are modulating within specifications.

Christian Communications Association ("CCA")

It is reassuring that there was analysis done when the 97.7 filter was installed. It is helpful when stations retain documentation of their engineering assessments, including a brief description of test methodology and results. If such a document is available it would help me provide a more complete picture of the situation at the site.

CCA suggests the problem with the interaction of 97.7 and 96.5 in receivers and affecting reception of 98.9 is an intermodulation problem, not a blanketing problem. Indeed in the coarse sense that blanketing means a receiver is positively swamped by a very strong signal, this is one potential mechanism but not the only potential mechanism for inducing the interference noted. In fact, one of the manifestations of blanketing is receiver intermodulation. As the phenomenon was also noticed at a modest distance from the transmitter site, some might discount the idea that brute force blanketing was occurring there. However, if the local signals are strong enough to cause the receiver to intermodulate when the desired signal is momentarily below a signal level threshold, it is still the proximity and strength of the undesired signals that is promoting the experience of interference. So whether it is called blanketing or not, the phenomenon of receiver overload induced intermodulation around George Town affects reception of the more distant 98.9.

Also, Radio Cayman reports in its recent comments that it experiences interference to some mobile reception at the nearby roundabout. As a matter of public policy, is the existing interference in the area with the remaining George Town Three stations benign enough to "grandfather" these facilities at their current power and coverage characteristics? Is it equitable to maintain this status quo while other stations are precluded from achieving similar results?

The suggestion to change frequency of the 97.7 facility would help address the unique problem of 96.5 and 97.7, both of which are George Town signals, intermodulating in receivers and affecting 98.9, a signal from outside the town. A frequency change would not address the broader issues raised here and therefore would best be executed only with other clarifications of policy.

Mr. & Mrs. Gould

Mr. and Mrs. Gould accurately observe that our assessment of the signal strength of the George Town Three stations in the West Bay area is marginal, at best, and below ITU standards for monophonic reception, at worst. While this makes these stations culpable for less than reliable coverage in the West Bay area, it does not obviate the potential for interference from the proposed facility on 94.3. Even with upgraded power levels from the George Town Three, there will still be a blanketing area around the proposed facility. It is a policy question as to whether the blanketing area is benign enough to permit the facility to operate and whether the station should operate at higher power to reach the entire island or lower power to minimize interference.

I agree that a shift to 94.1 moving the station from 94.9's third-adjacent (94.3) to fourth-adjacent channel (94.1) would be helpful in avoiding some adjacent channel interference in some radios. It is a good suggestion regardless where the station would be physically located. In 2006 we prepared two band plans, one based on three-channel spacing, which nearly demands co-location of all facilities, and one based on four-channel spacing, which can better tolerate some geographic diversity of stations. Following the four-channel spacing, 94.1 would be a prudent choice.

Conclusion

The comments received indicate that the public policy decision on how to treat the remaining George Town stations is a thorny one. There are issues of equity on both sides of the coin. If the ultimate goal is maximum availability of the maximum number of FM channels at the maximum practicable number of locations on the island, to the maximum number of people, then continued migration toward centralized, full power facilities is in order. If it is determined that it will be acceptable for certain broadcasters, by virtue of being grandfathered or being of lesser means to have lower-powered facilities at offset locations, then the status quo could be retained. In the opposite extreme, it could be determined that future facility siting should be entirely left to the marketplace, and little regulation of facility location would be applied. Experience in recent years informs the discussion of this option.

Some of the comments are, at best, suspicious of our technical conclusions. This can be healthy in the public discourse, as long as further competent study is performed to validate (or invalidate) our conclusions. I hope we have lain to rest any misconceptions that may have arisen in the minds of some of the participants.

Yours truly,

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24 April 2008