

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

In the Matter of)
)
Amendment of Section 90.20(e)(6) of the) WT Docket No. 06-142
Commission's Rules) RM-11135

COMMENTS OF LOJACK CORPORATION

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SUMMARY

In this filing, LoJack comments as follows on the Commission's proposals to modify the SVRS rules:

SVRS Power Limits. Raising the SVRS power limits will improve system performance and enable law enforcement authorities to operate fewer receivers. The power limits for SVRS mobile transceivers should be raised from 2.5 watts to 5 watts, which (as the Commission acknowledges) will have a *de minimis* impact on interference potential. The ERP limits for SVRS base stations should be raised from 300 watts to 500 watts. LoJack shows in its comments that the increase is needed to compensate for performance degradation that will occur as its system migrates to narrower channels and demonstrates that the increase will not interfere with TV reception on Channel 7.

Digitally Modulated Emissions. To enhance flexibility, SVRS licensees should be permitted to operate using any emission designator.

Duty Cycle Limits. LoJack supports the Commission's proposals for raising the duty cycle limits for SVRS base stations and VLUs. As a refinement to the Commission's proposals, LoJack suggests applying the VLU duty cycle relief to 12.5 kHz and 20 kHz VLUs, rather than just to 12.5 kHz VLUs. This refinement will: (1) avoid having different duty cycle limits for 12.5 kHz and 20 kHz VLUs that will be operating side by side during the SVRS transition to narrower channels; (2) have no appreciable impact on the potential for interference with Channel 7 TV reception, because 20 kHz VLUs and 12.5 kHz VLUs both are narrowband vis-à-vis 6 MHz

television channels; and (3) provide a jump start to the additional public safety services that LoJack is seeking authority for in this proceeding.

Channel 7 Interference Studies. The requirement to file a formal interference study every time a base station is added is no longer necessary. In the more than 20 years that the requirement has been in effect, there have been no findings of perceptible interference to viewers of Channel 7 and no recorded complaints of interference. LoJack would have no objection, however, to requiring that interference considerations be taken into account when selecting base station locations and mandating that a mitigation plan be in place if more than a *de minimis* number of residences potentially could be affected by a base station.

Licensing by Rule. The Commission should authorize licensing by rule of SVRS mobile stations that are not associated with licensed base stations. This change would make it possible, in the case of mobile units employing cellular technology, to expand the coverage of LoJack's system from 26 states (and the District of Columbia) to 50 states.

Permitted Services. The permissible uses of SVRS should be expanded to include additional services that would advance the law enforcement goals underlying the SVRS rules. To satisfy the Commission's concern that the SVRS frequency should not be overused, only activation, tracking, and location services would be permitted; any activation, tracking, and location would have to be performed for emergency response purposes; and the activation of the tracking units would have to remain under the control of law enforcement entities.

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COMMENTS OF LOJACK CORPORATION

LoJack Corporation (“LoJack”), by its attorneys, hereby comments on the Notice of Proposed Rulemaking (“NPRM”) in the above-captioned proceeding.¹

I. INTRODUCTION

In the NPRM, the Commission seeks comment on proposals to amend Section 90.20(e)(6) of the Commission's rules,² which governs Stolen Vehicle Recovery System (“SVRS”)³ operations on 173.075 MHz. LoJack commends the Commission for initiating this rulemaking. The proposals made in the NPRM, if adopted with the modifications suggested in these comments, will further the Commission's policies favoring spectrum flexibility; improve stolen vehicle recovery; aid public safety agencies in carrying out their responsibilities; expand the range of radio-based public safety/security services that are available to consumers; and enhance spectrum efficiency.

¹ *Amendment of Section 90.20(e)(6) of the Commission's Rules*, Notice of Proposed Rulemaking, FCC 06-107 (July 24, 2006).

² 47 C.F.R. § 90.20(e)(6).

³ As used in these comments, the term “SVRS” includes the Stolen Vehicle Recovery System service as presently configured and as it might be configured following any rule changes adopted in this proceeding.

The Commission issued the NPRM in response to a petition for rulemaking (“Petition”) that LoJack had filed.⁴ As discussed in LoJack’s Petition, a convergence of factors presents a unique opportunity to improve the use of 173.075 MHz. With LoJack’s support, the Commission has adopted rules providing for the migration of SVRS systems from wideband operations to narrowband operations.⁵ As a result, LoJack is embarking on a complete redesign of the hardware and software components of its system. This redesign will enable LoJack to take advantage of technological advances that followed the adoption of Section 90.20(e)(6) and will enable LoJack to add system capabilities that are responsive to the growing needs of law enforcement authorities and consumers for radio-based public safety and security services. In its Petition, LoJack sought rule changes that are intended to unlock the potential of LoJack’s redesigned system.

II. BACKGROUND

Section 90.20(e)(6) of the Commission’s rules authorizes SVRS operations on 173.075 MHz on a shared basis with federal government users.⁶ The LoJack SVRS, operated in conjunction with state and local police departments, is the most extensive radio-based stolen vehicle recovery system in the world. Since 1989, when the Commission authorized LoJack to operate on a regular basis, LoJack has deployed its system nationally in twenty-six states and the District of Columbia, an area that accounts for approximately two thirds of the vehicle sales and vehicle thefts in the United States. The proposed rules changes would facilitate expansion of the system into the remaining states.

⁴ Petition for Rulemaking of LoJack Corporation, RM-1113 (Oct. 25, 2004).

⁵ See *Amendment of Parts 2 and 90 of the Commission's Rules to Provide for Narrowband Private Land Mobile Radio Channels in the 150.05-150.8 MHz, 162-174 MHz, and 406.1-420 MHz Bands that are Allocated for Federal Government Use*, Report and Order, ET Docket No. 04-243, 20 FCC Rcd 5793 (2005), *Erratum*, 20 FCC Rcd 9882 (OET 2005).

⁶ 47 C.F.R. § 90.20(e)(6).

LoJack has licensed its technology in 25 countries, including Mexico, Argentina, Brazil, Colombia, Venezuela, Ecuador, the United Kingdom, South Africa, Spain, France, Italy, Germany, Poland, and Russia. With the exception of Ecuador, most countries in North, Central, and South America have made 173.075 MHz available, using 20 kHz, “wideband” channels, for purposes similar to those provided for in the Commission’s rules.⁷ This frequency uniformity enhances law enforcement effectiveness in areas such as recovering stolen vehicles, providing border control, and tracking hazardous cargo, thereby contributing to public safety and homeland security.⁸

The LoJack system is comprised of three pieces of equipment: Vehicle Location Units (“VLUs”) located in motor vehicles; Vehicle Tracking Units (“VTUs”) located in police vehicles⁹; and base stations licensed to law enforcement agencies in twenty-six states and the District of Columbia. LoJack also employs sophisticated software to run the system. In the United States LoJack VLUs are currently installed in more than 3 million vehicles and can be tracked by 11,000 VTUs; law enforcement agencies operate approximately 175 base stations with more of each being added each year.

LoJack’s stolen vehicle recovery network operates as follows. VLUs are hidden in vehicles and remain dormant until activated by the police. When a vehicle owner submits a stolen vehicle report to the police, the information is entered into a central law enforcement computer linked to the LoJack SVRS. This computer system, in turn, causes the “Sector

⁷ Canada uses 173.070 MHz and 15 kHz channels for stolen vehicle recovery.

⁸ In a number of countries, 173.075 MHz may be used for law enforcement tracking, location, and recovery purposes that extend beyond stolen vehicle recovery. That is true in the United States as well, because the Commission has granted LoJack a waiver, subject to the outcome of this rulemaking proceeding, permitting its system to be used for tracking and recovery of hazardous materials or cargo. *See Order*, DA 05-3340 (Dec. 29, 2005).

⁹ These were formerly known as Police Tracking Computers.

Activation System,” a network of radio base stations licensed to the police, to periodically transmit a uniquely coded “activation” message. The activation message is transmitted until the vehicle is recovered or, in areas that have been upgraded to incorporate an “early response” feature, until the base stations receive an acknowledgment from the VTU.

The activation message instructs the VLU to begin transmitting a brief periodic “tracking” message. The “tracking message” contains a unique reply code, which is received by the VTUs installed in police vehicles. Police identify the vehicle make, model and registration from the reply code, and then track and recover the stolen vehicle.

LoJack offers an optional early warning system that can detect if a vehicle is operated without the owner’s key. If unauthorized operation is detected, LoJack notifies the owner who, if the vehicle has been stolen, notifies police. The system’s base stations and law enforcement’s VTUs then are activated in the same manner as when a vehicle owner reports directly that his or her vehicle has been stolen.

To date in the United States alone, LoJack’s system has assisted in the recovery of more than 90,000 vehicles, with an estimated total value of over \$1,500,000,000. On many occasions when police recover a LoJack-equipped vehicle, they also recover other stolen vehicles and vehicle parts that are present. The police have found the SVRS technology to be useful in solving other criminal activity, such as the production of illegal drugs, and have achieved a recovery rate of LoJack equipped vehicles of more than ninety percent. SVRS technology also provides an added margin of safety for the police by making them aware that a vehicle is stolen before the vehicle is stopped.

III. THE SVRS POWER LIMITS SHOULD BE RAISED.

LoJack proposed in its Petition that the maximum effective radiated power (ERP) for SVRS base stations be increased from 300 watts to 500 watts and that the maximum output power for mobile transceivers be increased from 2.5 watts to 5 watts. LoJack based its request on the fact that power increases are needed to compensate for the reduced range that SVRS base stations, mobile transceivers, and tracking units will have as a result of the mandatory transition to narrower SVRS channels.¹⁰ LoJack also relied on the fact that higher VLU power will enable law enforcement authorities to operate fewer receivers, thereby freeing up resources for other public safety purposes.

In the NPRM, the Commission proposed to adopt the suggested power increase for mobile transceiver VLUs. It found that “any interference resulting from increasing the maximum [VLU] power limit ... appears, at worst, *de minimis*” because VLUs “operate with antenna elevations and power levels significantly lower than the base stations, and are generally transient.”¹¹ LoJack concurs with the Commission’s analysis, and urges it to increase the maximum output power for VLUs to 5 watts.¹²

The Commission’s findings concerning the proposed power increase for SVRS base stations were more tentative. The Commission stated that, before it could approve

¹⁰ See *Amendment of Parts 2 and 90 of the Commission's Rules to Provide for Narrowband Private Land Mobile Radio Channels in the 150.05-150.8 MHz, 162-174 MHz, and 406.1-420 MHz Bands that are Allocated for Federal Government Use*, Report and Order, ET Docket No. 04-243, 20 FCC Rcd 5793 (2005), *Erratum*, 20 FCC Rcd 9882 (OET 2005).

¹¹ NPRM, ¶ 12.

¹² In connection with this issue, the Commission asked whether the potential for Channel 7 TV reception to be interfered with by VLUs would be affected by the proposal to expand permissible SVRS uses beyond recovery of stolen vehicles. NPRM, n. 29. There should be no appreciable impact on Channel 7 TV interference if VLU power is increased and SVRS permissible uses are expanded, because interference potential will continue to be a function of the transient operations of individual mobile units that employ low power (albeit higher power than previously).

the base station increase that had been requested, LoJack would need to show more explicitly the extent to which narrowband operation would degrade the performance of LoJack's system and would have to demonstrate that the proposed power increase would not unduly increase the potential for base station interference to Channel 7 television reception.¹³

Attachment A hereto provides a technical analysis that is responsive to the narrowband degradation issue. It shows that when LoJack's base stations transmit in a narrowband mode, narrowband VLU's and legacy wideband VLU's will experience a degradation of up to 7 dB in output signal to noise ratio, as a result of which "the Bit Error Rate of the Narrowband System ... [will be] many orders of magnitude worse than the Wideband System over much of the dynamic range of the system."¹⁴ Increasing base station power by 200 watts, which is the equivalent of 2.2 dB, will only partially compensate for this degradation.¹⁵

Attachment B hereto provides a technical analysis that is responsive to the Channel 7 TV reception issue. It shows that base stations operating with an ERP of 500 watts will not interfere with digital TV reception on Channel 7.¹⁶ As stated in the technical analysis, "it is predicted that the maximum, undesired signal permissible from a lower adjacent channel LoJack transmitter can be at least 10 dB higher for adequate DTV reception than for analog TV reception."¹⁷ Accordingly, a digital Channel 7 television

¹³ NPRM, ¶ 13.

¹⁴ Attachment A, p. 1.

¹⁵ Attachment A, p. 1.

¹⁶ Television stations are required to convert from analog transmission to digital transmission no later than February 18, 2009. See Title III of the Deficit Reduction Act of 2005, S. 1932, Public Law 109-171, 120 Stat. 4, 109th Cong., 2nd Sess.

¹⁷ Attachment B, p. 6.

station seeking to replicate its analog coverage “would see a reduction in predicted interference ... even if the LoJack base stations ... were to raise transmitter power ... as proposed.”¹⁸

In sum, the Commission should adopted the proposed power increases because the impact of the power increase for VLUs will indeed be *de minimis* and because the power increase for base stations will compensate for the degradation caused by narrowbanding, but will not interfere with Channel 7 TV reception.

IV. DIGITALLY MODULATED EMISSIONS SHOULD BE PERMITTED.

At present, only F1D and F2D emissions, both of which are analog, are permitted for SVRS operations. LoJack proposed in its Petition that Section 90.20(e)(6) be amended so that any emissions, analog or digital, could be used.

In the NPRM, the Commission recognized that expanding permitted emissions could “provide increased flexibility to LoJack during the redesign of its system as it transitions to narrowband operation.”¹⁹ It sought comment as to whether it should add specific emission designators to the rule or, alternatively, should permit any emission designator to be used.

LoJack supports the latter alternative. If SVRS operations were limited to specific emission designators, there would be a risk that the approved list of designators would prove insufficient in the future. At that point, a rulemaking would be required to add emission designators and Commission resources would be expended to update the list again. The better course, therefore, would be to give SVRS licensees the flexibility at the outset to use any

¹⁸ Attachment B, p. 6.

¹⁹ NPRM, ¶ 15.

emission designators they determine are necessary or desirable consistent with the technical requirements of the SVRS rules.

V. THE DUTY CYCLE REQUIREMENTS SHOULD BE LIBERALIZED.

LoJack proposed in its Petition that the Commission eliminate all duty cycle restrictions for SVRS base and mobile stations. LoJack showed that dispensing with the duty cycle restrictions would enable it to operate parallel narrowband and wideband systems during the multi-year transition period to narrowband operations (dual systems require more “air time” than single systems); would provide an incentive for continued innovation; and would make it possible to use the LoJack system for additional public safety and security services. A less restrictive duty cycle also would facilitate added functionality such as transmitting GPS coordinates to make for quicker tracking and recovery.

In the NPRM, the Commission determined that “some form of relief from the duty cycle restrictions for base stations and VLUs is needed.”²⁰ In balancing the benefits of duty cycle relief against the need to protect Channel 7 TV reception and the needs of federal users, however, the Commission tentatively concluded that something short of complete elimination of duty cycle restrictions is warranted. It proposed instead that the duty cycle limit for SVRS base stations be increased from one second per minute to five seconds per minute; that the general duty cycle limit for VLUs be increased from 200 milliseconds every ten seconds to 400 milliseconds every ten seconds; and that the duty cycle limit for VLUs that are being actively tracked be increased from 200 milliseconds per second to 400 milliseconds per second.²¹

²⁰ NPRM, ¶ 17.

²¹ NPRM, ¶¶ 17-18.

Although LoJack would have preferred that the duty cycle restrictions be eliminated, it believes that, subject to one suggested refinement, the Commission's proposal strikes an acceptable balance between conflicting considerations. The suggested refinement relates to the fact that the duty cycle relief proposed in the NPRM for VLUs at present is limited to VLUs operating on narrowband channels. As discussed below, the relief should be extended to all VLUs.

First, it would be impractical to operate narrowband and non-narrowband SVRS systems side by side during the multi-year transition period if there are different duty cycles – one for 12.5 kHz channel mobile stations, and another for 20 kHz channel mobile stations – with which VLUs must comply. Second, extending duty cycle relief to all VLUs, rather than just to narrowband VLUs, will have no appreciable impact on the potential for interference with Channel 7 TV reception. Although 12.5 kHz channels are narrower than 20 kHz channels, they are both narrow signals from the perspective of a 6 MHz television channel. Finally, granting duty cycle relief to 20 kHz VLUs, which will remain on the market for many years to come, will provide a jump start to the additional public safety services that LoJack is seeking authority for in this proceeding.

The revisions to the duty cycle restrictions proposed in the NPRM reflect a conservative approach that provides ample protection for Channel 7 TV reception. Following adoption of these revisions, it would remain the case that most of the time SVRS stations would not be transmitting. At any one time in any given area, there generally are no stolen cars that are being tracked. Even when stolen vehicles are being tracked, moreover, the new duty cycle restrictions would limit transmissions to a fraction of the available air time.

Accordingly, the Commission should adopt the duty cycle revisions proposed in the NPRM, as modified by the refinement suggested in these comments.

VI. THE CHANNEL 7 INTERFERENCE STUDY REQUIREMENT SHOULD BE ELIMINATED.

Section 90.20(e)(6) of the Commission's rules requires SVRS applicants to conduct Channel 7 interference studies for base stations that are within 169 kilometers of a Channel 7 facility. The base stations will be authorized "if the applicant has limited the interference contour to fewer than one hundred residences ... or if the applicant develops a plan to control any interference and agrees to make such adjustments in affected TV receivers as may be necessary."²²

In its Petition, LoJack sought to eliminate the Channel 7 interference study requirement. LoJack showed that the studies are technically and financially onerous and provide no demonstrable benefit. To the contrary, during the period that SVRS applicants have been required to conduct the studies, which is in excess of 20 years, there have been no findings of perceptible interference to viewers of Channel 7 and no recorded complaints of interference.

No one opposed LoJack's proposal, and the Commission, in the NPRM, sought comment on the proposal and on alternative measures that could be adopted to accomplish the same purpose.²³ Although the Commission was willing to entertain comments on this issue, it emphasized the importance of avoiding interference to Channel 7 and stated that "the public interest is better served by minimizing the potential for interference prior to its occurrence, rather than afterwards."²⁴

²² NPRM, n. 41.

²³ NPRM, ¶¶ 19-20.

²⁴ NPRM, ¶ 20.

LoJack agrees with the Commission, and did not mean to suggest that the SVRS applicants and licensees should be absolved of the responsibility to take preventive interference measures. Rather, LoJack's position is that, in light of the unbroken record of success in avoiding interference to Channel 7 reception, the formal station-by-station interference study procedures of Section 90.20(e)(6) have outlived their usefulness. LoJack has no objection to the Commission making clear, in connection with an elimination of these procedures, that SVRS applicants must continue to locate their base stations with interference considerations in mind, and must continue to have plans in place, if more than a *de minimis* number of residences would be affected by a base station, to control interference and to make such adjustments in affected TV receivers as may be necessary.

VII. LICENSING BY RULE SHOULD BE IMPLEMENTED FOR MOBILE UNITS THAT ARE NOT ASSOCIATED WITH LICENSED BASE STATIONS.

In its Petition, LoJack requested that the Commission authorize VLUs to be operated on a "license by rule" basis. This change would have multiple benefits in the case of vehicles equipped with VLUs incorporating cellular technology. It would expand LoJack's coverage from 26 states (and the District of Columbia) to all 50 states, because it would enable police departments to activate VLUs (via cellular connection) in those areas in which base stations have not been licensed and constructed. It also would make it possible, in areas in which base stations have been licensed and constructed, to use cellular technology to activate VLUs without having to transmit on the system's base stations, thereby reducing the times during which the base stations will be in operation.

In the NPRM, the Commission recognized that “it may be more expeditious and efficient to permit hybrid licensing of SVRS systems by rule.”²⁵ It found that licensing VLUs by rule “would permit rapid deployment of a system that could offer truly nationwide coverage,” and observed that it already had adopted licensing by rule for the Radio Control Service, which like SVRS “involve[s] transmitting non-voice communications over short distances.”²⁶ The Commission also alluded to the possibility that licensing VLUs by rule would “minimize regulatory burdens on both licensees and the Commission.”²⁷ For all of the reasons articulated in the NPRM and in LoJack’s Petition, licensing by rule should be implemented for SVRS mobile units.

The Commission has raised the issue of who should be responsible for ensuring that SVRS mobile units authorized on a license by rule basis are operated consistent with FCC requirements.²⁸ At the outset, LoJack notes that compliance issues are largely theoretical, because its VLUs are low power devices that are manufactured in accordance with specifications based on which the equipment has been certified by the Commission. In the event that a compliance issue were to arise, however, LoJack proposes that it maintain a toll free number at which it can be contacted at any time for information concerning which public safety entity is operating VLUs on a license by rule basis in the area in question. LoJack also would make this information available upon request to NTIA to address the concern expressed in the NPRM that federal government users need to be aware of the geographic areas in which there are SVRS operations.²⁹

²⁵ NPRM, ¶ 21.

²⁶ NPRM, ¶ 23.

²⁷ NPRM, ¶ 23.

²⁸ NPRM, ¶ 24. *See also* NPRM, ¶ 23 (“Interested parties also should address whether a VLU notification or registration procedure would serve a useful administrative purpose.”).

²⁹ *See* NPRM, ¶ 24.

The Commission has asked whether, if it implements a license by rule regime, it nevertheless should continue to license SVRS mobile units that are associated with licensed based stations.³⁰ Although it would be acceptable to LoJack to license all mobiles by rule, the company suggests that the current system be retained for VLUs that are controlled by licensed base stations. When a police agency files an application with the Commission for a base station license, it already provides all of the information concerning associated mobile units that is needed for FCC enforcement purposes and for purposes of coordination with federal users. Given this fact, subjecting the mobile units to license by rule procedures would be redundant.

VIII. THE SERVICES PERMITTED UNDER SECTION 90.20(e)(6) SHOULD BE EXPANDED.

Section 90.20(e)(6) limits operations on 173.075 MHz to the recovery of stolen vehicles by law enforcement agencies. LoJack proposed in its Petition that the permissible uses of the frequency be expanded to include other services to be provided by law enforcement entities. LoJack gave the following examples of services that might be available under an expanded rule: (1) tracking stolen articles such as cargo containers, Automated Teller Machines, hazardous materials and nuclear waste; (2) addressing user emergencies by providing automatic collision notification, medical emergency or vehicle fire notification, and carjacking alerts; (3) tracking missing or wanted persons; (4) locating people at risk such as Alzheimer's patients, autistic children, sex offenders, parolees, and individuals under house arrest, if established boundaries are violated; and (5) location on demand services authorized by public safety agencies.

In the NPRM, the Commission recognized that putting SVRS operations to additional uses could further the purposes of Section 90.20(e)(6).³¹ The Commission was concerned,

³⁰ NPRM, ¶ 23.

³¹ NPRM, ¶ 26.

however, that 173.075 MHz could be overused if the additional uses were not defined with sufficient specificity.³²

In response to the Commission's concern, LoJack directs the Commission's attention to several elements of LoJack's proposal that strictly limit the additional uses. First, only activation, tracking, and location services would be permitted. This limit would confine operations to a narrow class of services that are similar to the activation, tracking, and location services already provided on the LoJack system for vehicle recovery purposes. Second, any activation, tracking, and location would have to be performed for emergency response purposes, as a result of which concierge, convenience, and fleet management services would not be permitted. Third, the activation of the tracking units would have to remain under the control of law enforcement entities. These limits would ensure that 173.075 MHz would be used consistent with the law enforcement and public safety purposes to which the frequency is dedicated, giving due regard to the needs of federal government users and Channel 7 viewers.³³

³² *Id.*

³³ The Commission also has sought comment as to whether the additional services proposed by LoJack could be served by other means. NPRM, ¶ 26. Although there may be other technologies that are capable of providing these services, the LoJack system is a particularly appropriate vehicle for the services. It is a system that has been created for the purpose of, and is designed to facilitate location and tracking by law enforcement entities. If other technologies become available for these purposes, moreover, nothing would prevent law enforcement entities from using them.

CONCLUSION

For the reasons stated herein, the Commission should revise its SVRS rules in the manner described in these comments.

Respectfully submitted,

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ATTACHMENT A

1 ANALYSIS OF NARROWBANDING ON LOJACK NETWORK PERFORMANCE

1.1 Abstract

The LoJack Stolen Vehicle Recovery Network (SVRN) relies on a system of RF transmitters (referred to as base stations) that are operated by Law Enforcement agencies. Under current rules, these base stations transmit downlink signals at a maximum transmit power of 300 Watts ERP using a peak deviation of 4.5 kHz and a 25 kHz channel spacing (20 kHz occupied bandwidth).

These downlink signals are transmitted to Vehicle Locating Units (VLUs) hidden in protected mobile assets.

Once a protected mobile asset has been reported stolen there are numerous messages that need to be sent to the VLU from these base stations. The timely and efficient operation of the LoJack SVRN depends on these messages being received accurately and in a timely manner by the VLU.

The Narrowbanding initiative requires existing Wideband (20 kHz) users to transmit using 12.5 kHz channels. This will require a reduction in peak deviation to 2.0 kHz.

Two areas must be considered when assessing the performance impact of this ruling on the LoJack SVRN.

- A. New Narrowband VLUs that are installed after the Narrowband cutover, and
- B. Legacy Wideband VLUs that are installed in protected mobile assets now (typical lifespan of 10-15 years) and must continue to operate after the Narrowband cutover.

In the following it is shown that:

1. Narrowband VLU receivers receiving from Narrowband base station transmitters will have the same coverage area as Wideband VLU receivers receiving from Wideband base station transmitters as defined by the Received Signal Level (RSL) at the performance threshold of 50% correct message reception rate.
2. Narrowband VLU receivers receiving from Narrowband base station transmitters have up to 7 dB worse output SNR than Wideband VLU receivers receiving from Wideband base station transmitters when the RSL is above threshold. This results in the Bit Error Rate of the Narrowband System being many orders of magnitude worse than the Wideband System over much of the dynamic range of the system.
3. Legacy Wideband VLUs will require 1 dB (calculated value) to 2 dB (real hardware) more transmit power from Narrowband base station transmitters to have the same coverage area as Wideband VLUs receiving from Wideband base station Transmitters.
4. Legacy Wideband VLUs receiving from Narrowband base station transmitters have up to 7 dB worse output SNR than Wideband VLU receivers receiving from Wideband base station transmitters when the RSL is above threshold. This results in the Bit Error Rate of the Narrowband System being many orders of magnitude worse than the Wideband System over much of the dynamic range of the system.

Therefore, LoJack has requested a conservative increase from 300 Watts ERP to 500 Watts ERP (a 2.2 dB increase) to reduce the performance degradation as stated, offset by a desire to minimize potential interference with other services.

1.2 System Description

LoJack RF links use either FM-MSK or FSK modes of transmission.

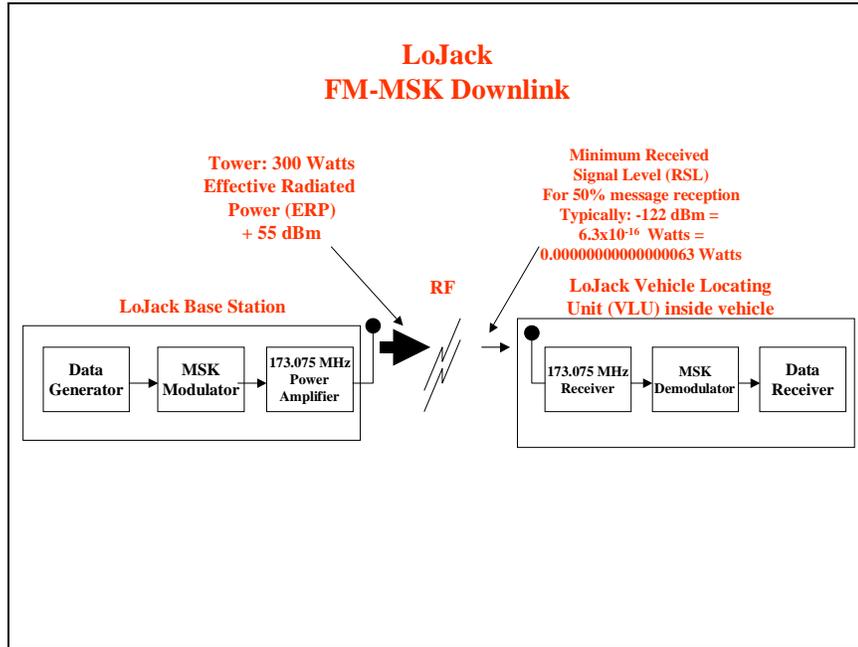
FM-MSK links consist of audio Minimum Shift Key (MSK) at 1190.476 bps burst data transmissions that are used to frequency modulate (FM) a radio frequency (RF) carrier at 173.075 MHz.

The peak frequency deviation (Δf) used in the wideband system (25 kHz channel spacing, 20 kHz occupied bandwidth allocation), is 4.5 kHz.

The occupied bandwidth (OBW) and the receiver Signal to Noise Ratio (SNR) are both proportional to the peak frequency deviation parameter of the transmitter.

The audio MSK requires approximately 10 dB of audio signal to noise ratio to operate at the 50% message reception threshold (defined as the criteria for system threshold in LoJack Document 4305-0001-PS).

A block diagram of a LoJack FM-MSK link is shown below.



FM transmission systems can be broadly broken down into Wideband FM and Narrowband FM. The classification is based on the Modulation Index (β) of the particular system.

The modulation index (β) is the ratio of the peak frequency deviation (Δf) to the highest frequency of interest in the modulating signal (f_m).

$$\beta = \frac{\Delta f}{f_m}$$

Wideband FM systems exhibit a threshold effect where at above a certain Carrier to Noise Ratio (CNR) the demodulated audio SNR jumps up by an amount proportional to the peak frequency deviation.

FM systems with $\beta < 0.81$ are considered narrowband.

Narrowband systems do not exhibit a threshold effect.

The LoJack Wideband system has a modulation index of:

$$\beta = \frac{\Delta f}{f_m} = \frac{4500\text{Hz}}{3000\text{Hz}} = 1.5$$

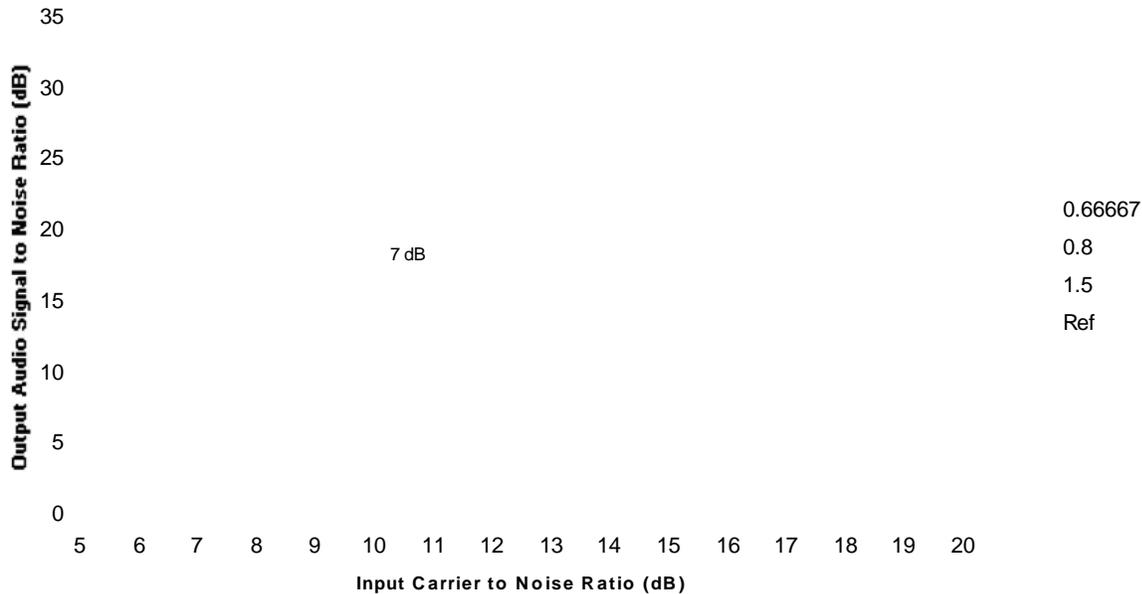
The LoJack Narrowband system has a modulation index of:

$$\beta = \frac{\Delta f}{f_m} = \frac{2000\text{Hz}}{3000\text{Hz}} = 0.6667$$

The output SNR of an FM receiver is a non-linear function of the transmitted frequency deviation, and the receiver noise bandwidth.

Figure 2 shows a plot of an equation derived by Taub and Schilling [1] relating the output SNR to the input CNR for several values of β for an FM system around threshold. The Wideband system uses a β of 1.5 (4,500Hz / 3,000Hz) and the Narrowband system uses a β of 0.667 (2,000Hz / 3,000Hz).

Figure 2: Plot of the FM Threshold Effect from equation derived by Taub and Schilling [1] relating the output SNR to the input CNR.



WIDEBAND vs. NARROWBAND PERFORMANCE COMPARISON

To compare the performance of the wideband and narrowband systems we look at two areas. First the low CNR region specifically where the audio SNR is 10 dB, and then the high CNR region (CNR > 15 dB).

LOW CNR REGION COMPARISON

The system performance metric for LoJack transmissions is a 50% message error rate after error correction. Reception of MSK using a non-coherent receiver requires a minimum of 10 dB audio SNR to meet the minimum performance level of a 50% message error rate.

The Wideband system requires approximately 11.8 dB CNR and the Narrowband system requires approximately 12.6 dB CNR. Therefore the Narrowband system requires 0.8 dB more CNR to maintain the same performance level of a Wideband system.

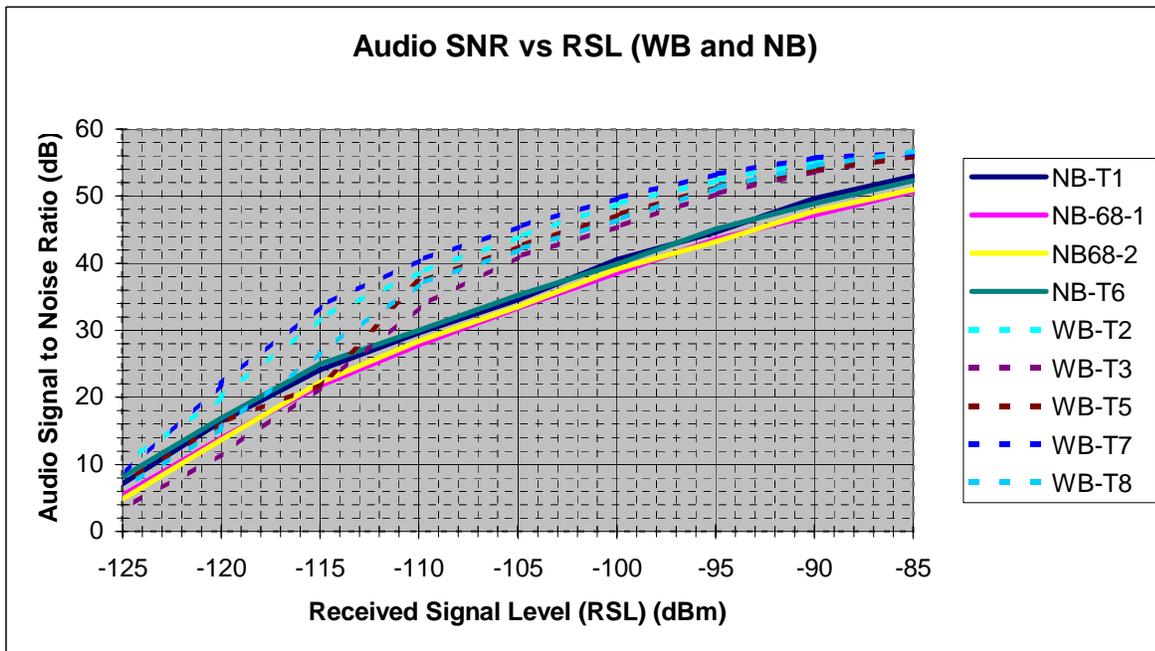
However, these numbers are independent of receiver Noise Bandwidth.

The Wideband receiver uses 15 kHz (3dB BW) filters and the Narrowband receivers use 9 kHz wide filters. The Narrowband receiver has $10^{*(\text{LOG}_{10}(15/9))} = 2.2$ dB less noise at any given Received Signal Level (RSL). Therefore at any given RSL the Narrowband receiver should have a 2.2 dB better CNR than a Wideband receiver.

From above it was calculated that the narrowband receiver should require 0.8 dB more CNR for the same threshold performance as a wideband receiver. Combining this with the fact that the Narrowband receiver theoretically has 2.2 dB less noise at any RSL due to the narrower receiver bandwidth, the Narrowband receiver is estimated to require 1.4 dB less Carrier power for the same threshold performance.

Several LoJack Vehicle Locating Units (VLU) were measured to assess their performance threshold characteristics. Figure 3 displays the results. It is seen that at the Audio SNR threshold of 10 dB the average performance of the Wideband and Narrowband receivers is centered around -123 dBm.

Figure 3: Plot of the Several WB and NB LoJack VLUs.



The 1.4 dB difference between the calculated and actual RSL at threshold can be attributed to design related circuit and process noise.

Therefore, in the low RSL region of the application map, the Wideband and Narrowband receivers perform the same.

HIGH CNR REGION COMPARISON

Theoretically (Figure 2), in the high CNR region (CNR > 15 dB), a Wideband receiver has an output SNR that is up to 7dB greater than a Narrowband receiver.

For real receivers (Figure 3) the Wideband system has 5 to 7 dB better output SNR in the high Received Signal Level region. For example at an RSL of -100 dBm the NB receivers average 40 dB SNR and the WB receivers average 47 dB SNR. There is less margin in some areas due to impairments in the real hardware.

From [2] the BER of non-coherent MSK is:

$$BER = \frac{1}{2} e^{-\frac{1}{2} \left(\frac{E_b}{N_0} \right)}$$

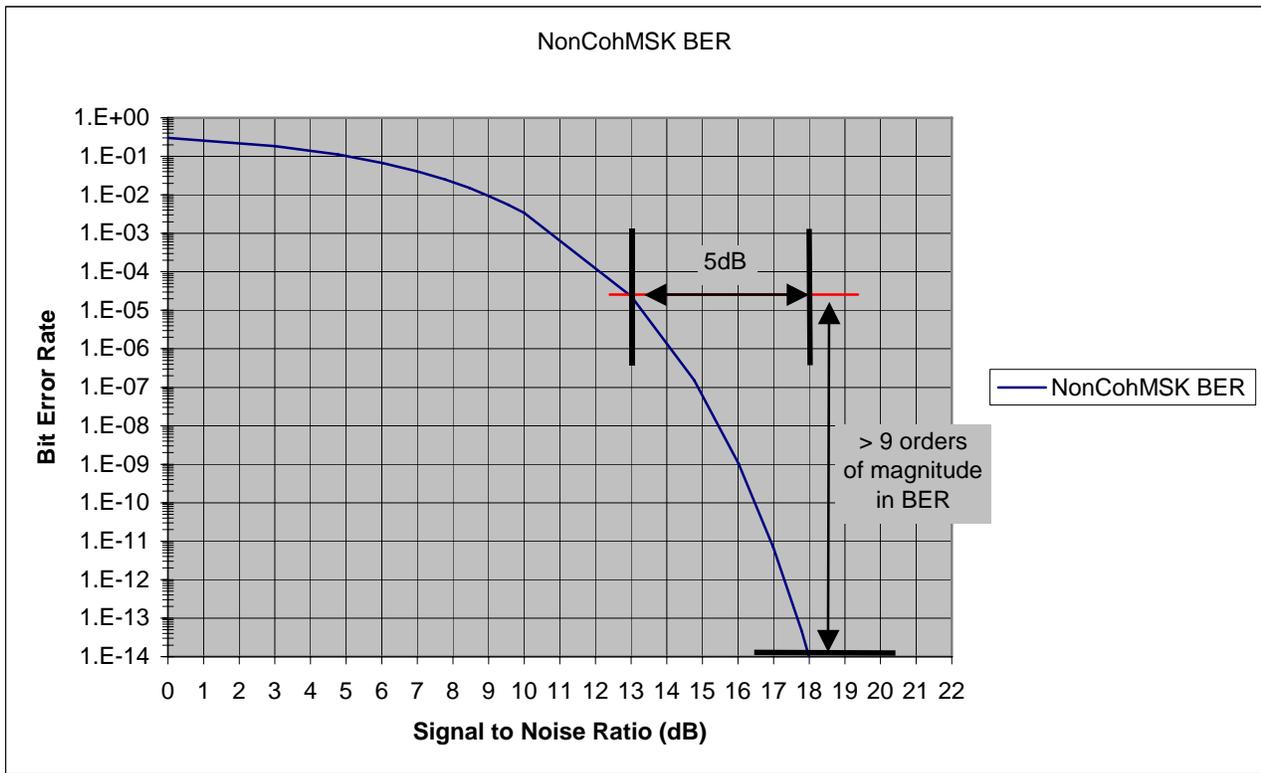
The calculated BER performance for non-coherent MSK is plotted below vs E_b/N_0 . E_b/N_0 is related to Signal to Noise Ratio by the relation:

$$\frac{E_b}{N_0} = \left(\frac{S}{N} \right) \left(\frac{f_b}{BW} \right)$$

Where f_b is the bit rate, and BW is the noise BW of the receiver. For this analysis they are assumed to be equal.

The BER of non-coherent MSK vs. SNR is plotted in Figure 4.

Figure 4: Plot of Bit Error Rate (BER) vs. Signal to Noise Ratio for Non-Coherently Detected MSK



From Figure 4 it can be seen that the difference in BER due to a 5 dB difference will be many orders of magnitude at some received signal levels.

In the current LoJack wideband system this margin has been used to mask other impairments in the system, such as noise from vehicle electronics and power systems. This has been instrumental in making the LoJack Stolen Vehicle Recovery System the affordable and extremely effective crime fighting tool for state and local law enforcement that it is today.

The Bit Error Rate of a Narrowband LoJack Transmission link will be degraded relative to the present Wideband LoJack system.

In this region the output Audio SNR increases dB for dB with increased RSL.

Therefore, LoJack has requested a conservative increase from 300 Watts ERP to 500 Watts ERP (a 2.2 dB increase) to reduce the performance degradation as stated, offset by a desire to minimize potential interference with other services.

REFERENCES

1. Taub, H., and D. L. Schilling, "Principles of Communications Systems", 2nd Edition, McGraw-Hill Book Company, New York, 1986.
2. Leon W, Couch II, "Digital and Analog Communication Systems", 4th Edition, Macmillan Publishing Company, 1993.

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Date: Sep 21, 2006

ATTACHMENT B

TECHNICAL EXHIBIT
IN SUPPORT OF COMMENTS IN WT DOCKET NO. 06-142
AMENDMENT OF SECTION 90.20(e)(6) OF THE COMMISSION'S RULES

This Technical Exhibit was prepared on behalf of the LoJack Corporation, the Petitioner in WT Docket No. 06-142, *Amendment of Section 90.20(e)(6) of the Commission's Rules*.

Within the WT Docket No. 06-142 Notice of Proposed Rule Making, the Commission stated its concern about the potential for interference to reception of Channel 7 digital stations from stolen vehicle recovery systems (SVRS) operations on 173.075 MHz if the LoJack base station effective radiated power is increased from the presently permitted 300 watts to 500 watts (2.2 dB increase in radiated power) and the vehicle location unit (VLU) output power is increased from 2.5 watts to 5 watts (3.0 dB increase in radiated power). As discussed herein, it is known that digital television receivers have an increased rejection of adjacent-channel undesired signals and therefore, the proposed increase in the LoJack base and VLU powers will not cause more interference to digital television reception than what is already predicted to be caused to analog television reception.

Although we know of no laboratory type testing done specifically to determine the interference impact of a narrowband LoJack type of signal spectra with 20 kHz or 11.25 kHz authorized bandwidth operating in the lower adjacent channel to a DTV receiver, the documented testing that has been done on the interference impact of a

television signal in the lower adjacent channel indicates a substantial improvement of DTV receiver rejection of out-of-band signals when compared with NTSC receiver out-of-band signal rejection characteristics.

The issue of DTV receiver performance on TV channel 7 in the presence of an SVRS signal operating in the lower adjacent channel was raised in a previous proceeding. As was pointed out in a report prepared for LoJack by Carl T. Jones entitled "Potential for Interference to DTV Reception from LoJack Transmissions" (herein, "Jones Report")¹, the Commission has already recognized that a DTV receiver shows a significant performance improvement over an NTSC receiver when in the presence of an undesired signal in the lower adjacent-channel.

The FCC has established a Desired-to-Undesired (D/U) protection ratio of -48 dB for lower adjacent channel analog TV into DTV but a D/U protection ratio of only -3 dB for lower adjacent channel analog TV into analog TV.² Thus, when considering lower adjacent-channel interference, the FCC's own interference methodology recognizes a 45 dB improvement in DTV receiver performance over that of an analog TV receiver. If we apply the appropriate D/U ratios at the predicted extent of service of a desired high-band VHF TV Channel 7 station, we obtain the maximum permissible interfering signal levels (expressed as a field strength in decibels relative to a microvolt per meter) from an

¹ See Potential for Interference to DTV Reception from LoJack Transmissions, prepared by Carl T. Jones Corporation, May 9, 2000.

² See OET Bulletin No. 69, Longley-Rice Methodology for Evaluating TV Coverage and Interference, February 06, 2004. DTV protection ratios are based on testing done on the Grand Alliance 8-VSB receiver at the Advanced Television Test Center.

undesired lower adjacent channel analog TV station as shown in Table 1.

Table 1 - Comparison of Interfering Signal from Lower Adjacent Channel Analog TV			
Desired Signal Type	OET 69 D/U Ratio	Desired Station Signal at Service Limit	Maximum Undesired Signal*
Analog TV	-3	56 dBuV/m (Grade B)	59 dBuV/m
Digital TV	-48	36 dBuV/m (noise limited)	84 dBuV/m

*Measured as peak visual signal. No additional factors for receive antenna polarization discrimination have been applied.

As can be seen in Table 1, the maximum, undesired signal permissible from a lower adjacent channel analog TV station can be 25 dB higher. It is obvious that a DTV desired station seeking to replicate its analog TV service with a new DTV service would see a significant reduction in predicted interference from a given, undesired, lower adjacent channel analog TV station.

If we adjust the -48 dB analog TV into DTV lower adjacent channel D/U ratio so as to reference it to an analog TV aural carrier operating at the FCC mandated maximum of 22 percent of peak visual carrier, we arrive at a D/U ratio of -41.4 dB relative to the interfering analog TV aural signal. Therefore, we would expect D/U ratio for a LoJack signal into a DTV receiver on channel 7 to be at least -41.4 dB.

As the Jones Report pointed out, a lower adjacent channel analog TV signal has its aural carrier removed only 250 kHz from the lower edge of the desired TV station's channel, whereas a LoJack base station's signal is removed 925 kHz from the lower edge of the desired channel 7 TV station's signal. Based on this frequency separation, we would certainly expect a DTV receiver to show at least the

same or better performance in rejecting out-of-band emissions from a LoJack signal 925 kHz removed from the lower channel edge compared to that from an analog TV aural signal located only 250 kHz from the lower channel edge.

The validity of the -41.4 dB D/U ratio is also supported by a Discrete Frequency Interference test performed on the digital HDTV Grand Alliance System.³ For this analysis, the susceptibility of DTV reception in the presence of a discrete non-modulated carrier frequency over a range from 3 MHz below the desired channel to 3 MHz above the desired channel was tested. At the frequency close to that of LoJack's with respect to the lower desired channel band edge, the measured D/U ratio was -47.44 dB.⁴

In 1985, LoJack submitted to the Commission results of testing done by *Micrologic, Inc.* on analog TV receiver performance on channel 7 in the presence of a LoJack signal operating on 173.075 MHz.⁵ The D/U ratio for just perceptible interference from a LoJack signal varied from -11 dB for a weak channel 7 analog TV signal to -8 dB for a strong channel 7 analog TV signal. If we apply the interference calculation procedure as outlined within the Micrologic Report to a desired digital channel 7 receiver and the -41.4 dB D/U value calculated in the previous paragraph to a digital channel 7 TV receiver, we obtain the following maximum undesired signals from a LoJack transmitter:

³ See Record of Test Results, digital HDTV Grand Alliance System, October, 1995.

⁴ The discrete frequency for this test was 203.0125, which is 9875 kHz away from the Channel 12 lower band edge. The LoJack emitter is located 925 kHz away from the Channel 7 lower band edge.

Table 2 - Comparison of Interfering Signal from Lower Adjacent Channel LoJack Signal			
Desired Signal Type	LoJack D/U Ratio	Desired Station Signal at Service Limit	Maximum Undesired LoJack Signal ⁶
Analog TV	-11	56 dBuV/m (Grade B)	77 dBuV/m
Digital TV	-41.4	36 dBuV/m (noise limited)	87.4 dBuV/m

Thus it is predicted that the maximum, undesired signal permissible from a lower adjacent channel LoJack transmitter can be at least 10 dB higher for adequate DTV reception than for analog TV reception. It is obvious that the desired station seeking to replicate its analog TV service with a new DTV service would see a reduction in predicted interference from a given, undesired, lower adjacent channel LoJack station, even if the LoJack base stations and VLU's were to raise its base station transmitter power by 2.2 dB and 3.0 dB, respectively, as proposed.

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⁵ See "Test Report on Potential for Interference to the Reception of Television Channel 7 Signals by Lo-Jack Transmissions", Micrologic, Inc., Watertown, MA, October 1985.

⁶ A 10 dB additional factor for receive antenna polarity discrimination has been applied as accepted by the Commission within the *Micrologic Report* since the LoJack base stations transmit antennas are vertically-only polarized.