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Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Re: GN Docket No. 17-183, *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*
***Ex Parte* Communication**

Dear Ms. Dortch:

On behalf of the Fixed Wireless Communications Coalition, Inc. ("FWCC"),[1] we are electronically filing this communication in the above-referenced docket.

This responds to a letter in the docket signed by Apple *et al*. ("RLAN Group") dated June 12, 2018 ("RLAN Group June 12 Ex Parte").

A. BACKGROUND

The Fixed Service ("FS") operates more than 95,000 licensed fixed service ("FS") microwave links in the 6 GHz bands. The applications include, among others, controlling oil and

[1] The FWCC is a coalition of companies, associations, and individuals interested in the fixed service – i.e., in terrestrial fixed microwave communications. Our membership includes manufacturers of microwave equipment, fixed microwave engineering firms, licensees of terrestrial fixed microwave systems and their associations, and communications service providers and their associations. The membership also includes railroads, public utilities, petroleum and pipeline entities, public safety agencies, cable TV providers, backhaul providers, and/or their respective associations, communications carriers, and telecommunications attorneys and engineers. Our members build, install, and use both licensed and unlicensed point-to-point, point-to-multipoint, and other fixed wireless systems. For more information, see www.fwcc.us.

gas pipelines, balancing the electric grid, synchronizing railroad trains, and backhaul of public safety communications. The critical nature of the applications requires most links to operate at reliability levels of 99.999% or 99.9999%. These numbers allow for total outages not to exceed five minutes or 30 seconds per year.

RLAN Group proposes to deploy 958 million RLAN devices in the 6 GHz bands at power levels up to +35.3 dBm. It submitted a technical study that claims to show the RLANs could coexist successfully with the FS systems.[2] The FWCC countered with its own study, showing the RLAN Group had underestimated the interference by several orders of magnitude, and that even RLAN Group's own numbers predict pervasive and consistent interference.[3] RLAN Group questioned some of our assumptions, and asserted that any interference could be controlled through mitigation.[4] We defended most of our assumptions, but changed our simulated RLAN power levels to meet RLAN Group's objection. The results still showed widespread interference.[5] We explained why the RLAN Group's proposed mitigation techniques, developed for other purposes, would not be effective here.[6]

RLAN Group has now clarified its mitigation proposals.[7] It states that interference would be (1) rare and exceptional, and (2) easily controlled through mitigation.[8] Part B below shows why the first proposition is wrong. Part C shows why the modified mitigation measures would still fall short, unless greatly improved.

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2 *Frequency Sharing for Radio Local Area Networks in the 6 GHz Band January 2018*, attached to Letter from Paul Margie, Counsel to Apple Inc., *et al*. to Marlene Dortch, Secretary, FCC (filed Jan. 26, 2018) ("RKF Study").

3 George Kizer, *Studies Regarding RKF's Frequency Sharing for Radio Local Area Networks in the 6 GHz Band Proposal*, attached to Letter from Cheng-yi Liu and Mitchell Lazarus to Marlene H. Dortch, Secretary, FCC (filed March 13, 2018) ("Kizer Analysis").

4 Letter from Apple Inc., *et al*. to Marlene H. Dortch, Secretary, FCC (filed May 14, 2018) ("RLAN Group May 14 Ex Parte").

5 Letter from Cheng-yi Liu and Mitchell Lazarus to Marlene H. Dortch, Secretary, FCC at 5-6 (filed June 8, 2018) ("FWCC June 8 Ex Parte").

6 FWCC June 8 Ex Parte at 15-17.

7 RLAN Group June 12 Ex Parte at 3-4.

8 RLAN Group June 12 Ex Parte at 2 ("[Our] analysis demonstrated that the risk to licensed incumbents from RLAN devices is very low and could be resolved through FCC rules imposing avoidance and mitigation mechanisms.")

The gravity of the interference issues follows from the safety-critical nature of some FS applications. Unplanned-for outages can result directly in loss of American lives. Even a brief interruption can take down a first responders' backhaul network for several minutes, during which 911 operators sit powerless, unable to summon help. Victims of house fires, heart attacks, severe accidents, and violent crime must simply wait for the interference to stop and service to resume.

The proceeding is not just about competing claims of dbs and probabilities, but about putting the lives of real people at risk.

B. What Mitigation Must Accomplish

Adopting RLAN Group's numbers for RLAN powers and geographical distribution, we showed that nearly all FS receivers would see interference in excess of 1 dB,[9] which is RLAN Group's own criterion.[10] Unacceptably large fractions would see much higher levels of interference, shown in Table 1.[11]

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[9] FWCC June 8 Ex Parte at 5-6.

[10] Kizer Analysis at 11. The 1 dB level is also the national and international standard. TIA/EIA, *Interference Criteria for Microwave Systems*, Telecommunications Systems Bulletin TSB10-F (June 1994); ITU-R Recommendation F.758-6, *System Parameters and Considerations in the Development of Criteria for Sharing or Compatibility between Digital Fixed Wireless Systems in the Fixed Service and Systems in Other Services and Other Sources of Interference*, Geneva: International Telecommunication Union, Radiocommunication Sector (Sept. 2015).

[11] For details on the simulation procedure, *see* Kizer Analysis at 1-7, summarized at Letter from Cheng-yi Liu and Mitchell Lazarus to Marlene H. Dortch, Secretary, FCC at 6-8 (filed March 13, 2018). The simulation reported there put all RLANs at 35 dBm. Following objections from RLAN Group, we reran the simulation using RLAN Group's distribution of RLAN powers. *See* FWCC June 8 Ex Parte at 5-6. Table 1 in text and attached Table A shows results from the revised simulation.

Fade Margin Reduction Due to RLANs	Fraction of FS Receivers Affected	Likely Consequence
over 1 dB	nearly all	exceeds RKF criterion
over 10 dB	over half	vulnerable to ordinary fades
over 20 dB	1/4	
over 30 dB	1/14	bit errors occur
over 40 dB	1/59	link fails

Table 1
Fractions of FS receivers that would experience interference from RLANs

A more complete summary of our simulation results is in Table A, attached. An example from Table A: of the 838 FS wideband FS receivers in the Houston TX study area, many serving the petroleum industry and some in safety-critical applications, 21 would be subject to near-certain failure from RLAN interference in excess of 40 dB.[12]

RLAN Group predicts a much lower level of interference than we do: namely, 0.209%.[13] RLAN Group has not disclosed the calculations that produce this result.[14] But even if RLAN Group's numbers were right, in an environment that includes 95,000 FS receivers, each with outages limited to 0.001% or 0.0001%, a predicted interference rate of 0.209% all but guarantees FS outages far more frequent than the design criteria permit.

RLAN Group responds to all such interference predictions with a wave of the hand, saying mitigation will solve the problem.[15] But saying it is not enough. RLAN Group must affirmatively show that the specific mitigation measures it proposes will reduce the interference sufficiently that RLAN-caused receiver outages over the course of a year come well below the permitted levels from other causes—*i.e.*, on the order of 3 seconds or 30 seconds. This will require making nighttime interference in excess of 1 dB extremely improbable. Given the large

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12 For an explanation of fading and fade margins, and of how interference affects FS receivers, *see* FWCC June 8 Ex Parte at 6-8.

13 RKF Study at 45.

14 *See* FWCC June 8 Ex Parte at 4.

15 RLAN Group June 12 Ex Parte at 2; RLAN Group May 14 Ex Parte at iii, 13, 14, 15, 16-17, 17, 20.

numbers of RLANs involved and their considerable power, the task will be difficult, if it is possible at all.

C. FWCC Response to Proposed Mitigation Measures

1. Outdoors

We welcome RLAN Group's proposal to have each outdoor RLAN self-locate and receive permission to operate on particular frequencies from an automatic coordination system based on FS receiver data.[16] Below we list the properties such a system would need.[17] We acknowledge that these conditions might limit the utility of RLANs in some environments—a consequence of attempting widespread unlicensed operation at relatively high powers in a heavily occupied licensed band.

An adequate automatic coordination system for outdoor devices will require:

- all devices, regardless of power, being subject to authorization;[18]
- adequately conservative interference criteria (I/N = -6 dB, equivalent to 1 dB fade margin degradation);[19]
- line-of-sight assumptions for every link, unless the coordination system uses a database that incorporates terrain and/or building information that identifies line-of-sight cases with an extremely high degree of reliability;
- use of a complete, accurate, and frequently updated FS receiver database (which ULS does not provide; but such databases exist, and access may be available for purchase);
- protection of adjacent channels in every case and, where necessary, protection of second-adjacent channels as well;

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16 RLAN Group June 12 Ex Parte at 3.

17 This expands on an earlier list drawn up before RLAN Group's most recent proposal. *See* FWCC June 8 Ex Parte at 16.

18 Even devices at very low power will cause interference if located within an FS antenna boresight. *See* Letter from Dave Meyer, National Spectrum Management Association, to Marlene H. Dortch, Secretary, FCC (filed March 27, 2018).

19 See footnote 10.

- when authorizing a client device through a master device, allowance for cases in which the master is at a non-interfering location but a client controlled by the master may not be;[20]

- periodic refresh of each RLAN authorization, with the RLAN locked out if the refresh cannot be successfully accomplished at the required time;

- prohibition of operation on aircraft or drones; and

- as a precondition to Commission approval and RLAN deployment, successful testing of the coordination system under realistic conditions and with the participation of FS operators.

2. Indoors

RLAN Group proposes a similar system of geographical exclusion for indoor devices that operate above some power level, with uncontrolled use allowed at lower powers anywhere indoors, on any frequency.

At 6 GHz, building walls provide only about 10-20 dB attenuation at most,[21] and almost none through glass. An indoor RLAN at the wrong location and the wrong frequency will cause severe interference. Attachment 2 shows that an indoor RLAN at the weighted-average power of 22.9 dBm, in the boresight of an FS antenna 1 km away and behind a 20 dB wall, will degrade the receiver fade margin by 19.4 dB—far in excess of the RLAN Group's criterion of 1 dB. This degree of interference will completely shut down a link experiencing even moderate fade. A link able to continue operating remains subject to failure from fades it could otherwise withstand.

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20 We discuss this case in Part D.2, below.

21 ITU-R Report P.2346-0, *Compilation of Measurement Data Relating to Building Entry Loss*, Geneva: International Telecommunication Union, Radiocommunication Sector (May 2015); Furgin, G., Rappaport, T. S. and Xu, H., *Measurements and Models for Radio Path Loss and Penetration Loss in and Around Homes and Trees at 5.85 GHz*, IEEE Transactions on Communications at 1484-95 (Nov. 1998); Loew, L. H., Lo, Y., Laflin, M. G. and Pol, E. E., *Building Penetration Measurements from Low-height Base Stations At 912, 1920, and 5990 MHz*, NTIA Report 95-325, Boulder: National Telecommunications and Information Administration, Institute for Telecommunications Sciences (Sept. 1995).

In consequence, all indoor devices, regardless of power, must be subject to the same automatic frequency coordination as outdoor devices.

But that may not be enough. We remain particularly concerned about indoor operations in buildings tall enough to provide line-of-sight to FS receivers. Where a location is safe for an RLAN to operate at ground level, the same RLAN on the 10th or 20th floor may cause disabling interference. The risk of encountering this worst-case geometry may be low for any one RLAN, but it approaches certainty with a large enough population.

In what it calls a conservative projection, RLAN Group puts 98% of its devices indoors.[22] That amounts to 934 million indoor devices, concentrated in urban and suburban areas, where the tallest buildings are—and where FS receivers are concentrated as well. If the probability of one RLAN on an upper floor having line-of-sight with an FS receiver were just one in a million, this still yields over 900 cases. Even taking duty cycle and channelization properly into account,[23] some of these cases are certain to shut down FS links. This is not an acceptable outcome.

The FWCC does not have a satisfactory solution to the problem of RLANs in tall buildings. One approach might equip the RLAN with a GPS receiver that accurately reports elevation as well as location. With a suitable database, the RLAN could identify the line-of-sight cases at its elevation. The problem is that a GPS receiver will often fail indoors when away from a window. An RLAN carried up in an elevator has no way of knowing its own altitude.

Another approach, not requiring elevation data, has flaws of a different kind. It would detect when the RLAN enters a building (perhaps by loss of GPS signal), look up the height of the building at that location (assuming a suitable database of building heights exists), and lock out the frequencies that might cause interference from any floor of the building. But that would eliminate RLAN operation even on lower floors, where it might be safe.

We ask the RLAN Group engineers to work with us toward finding a better solution—one that does not unnecessarily limit RLAN operation, yet poses no risk of harmful interference from indoor RLANs on upper floors. The issue is critical to the RLAN Group's meeting its Part 15 obligations.

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22 RKF Study at 14.

23 *See* FWCC June 8 Ex Parte at 11-13.

3. *Mitigation after the fact*

RLAN Group proposes that those RLANs implementing automatic frequency coordination also periodically transmit identifying information, on the theory that FS operators could identify and notify a device that causes interference.[24]

We explained earlier why this can't work.[25] An FS operator has no way to detect interference until after a link fails, and no way to tell whether the failure was caused by deep fade, RLAN interference, or something else. Even if the link were still operating, it could not decode the offending RLAN's ID information. RLAN Group must prevent interference from the start, and not rely on fixing it afterward.

4. *Other*

The proposal to ban outdoor 6.425-6.524 MHz operations does not help to alleviate FS concerns, as we do not operate in that band.

D. COMPARISON WITH HIGHER GROUND AND TV WHITE SPACE

RLAN Group's approach to automatic frequency coordination appears to be modeled on the Commission's approval of the Higher Ground mobile satellite uplinks in the 5,925-6,425 MHz band.[26] Its treatment of master and client devices follows the TV white space approach. Neither of these offers a suitable precedent here.

1. *Higher Ground*

The FWCC opposed Higher Ground's waiver on both substantive and procedural grounds,[27] and has an Application for Review pending.[28] But even if the *Higher Ground Order* were correctly decided, it does not provide useful guidance for the present case, which raises a far worse interference threat. We contrast the two:

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24 RLAN Group June 12 Ex Parte at 4.

25 FWCC June 8 Ex Parte at 16.

26 *Higher Ground LLC*, Order and Authorization, 32 FCC Rcd 728 (2017) ("*Higher Ground Order*").

27 *See generally* File No. SES-LIC-20150616-00357.

28 Fixed Wireless Communications Coalition, Application for Review, File No. SES-LIC-20150616-00357 (filed Feb. 10, 2017).

NUMEROSITY. The *Higher Ground Order* authorized 50,000 devices.[29] RLAN Group seeks to deploy 958 million.[30] For every one Higher Ground device, RLAN Group proposes 19,160 devices.

AREAS OF USE. The high cost and low capacity of Higher Ground's service,[31] relative to 3G/4G, means it will meet the greatest need away from the more densely populated area of the country, where 3G and 4G are available. But those densely populated areas are home to RLAN Group's expected user base,[32] and are also where most FS links are located.

DIRECTIONAL ANTENNAS. Where the Higher Ground antennas have a degree of horizontal suppression, and do not operate unless pointed upward toward a satellite,[33] RLAN Group devices have their maximum emissions in the horizontal plane. We explained why the elevation of an FS receive antenna does not provide a steep enough angle for any significant attenuation at the RLAN antenna.[34]

POWER. The maximum RLAN power is only 4 dB less than the Higher Ground power.[35] The vastly more numerous RLANs will swamp this small difference.

Any mechanism to prevent interference from RLANs must be shown to be effective with reference to the particulars of the RLANs, without recourse to a very different technology as precedent.

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29 *Higher Ground Order* at ¶ 1.

30 RKF Study at 13.

31 Higher Ground offers messaging and "light email." *Higher Ground Order* at ¶ 3.

32 RKF Study at 10 ("[U]rban and suburban areas comprise only 5% of CONUS land area but contain over 80% of the population, implying that interference will be concentrated predominately in these areas.")

33 *Higher Ground Order* at ¶ 14.

34 FWCC June 8 Ex Parte at 13.

35 The maximum RLAN power is 35.3 dBm. RKF Study at 18, Table 3-4. The Higher Ground power is 39 dBm. *Higher Ground Order* at ¶ 14.

2. TV white space

RLAN Group suggests that client devices be permitted to obtain channel availability from a master device, rather than directly from a database.[36] The proposal is similar to a Mode II TV white space device receiving channel information from a Mode I or fixed device.[37]

The arrangement works in the white space context because the areas that need protection on a given TV channel are typically the size of TV markets—very large compared to the area over which a Mode II device might operate around its controlling device. If the controlling Mode I or fixed device is in a safe location to operate on a particular channel, the chances are good that the Mode II will be safely located as well.

The same is not necessarily true in the 6 GHz context, where RLAN exclusion zones are much smaller.[38] A master device could be at a safe location while a client it controls is not. For this reason, the coordination of RLAN systems that include masters and clients must take into account not only the location of the master, but also the range of possible locations of the client.

CONCLUSION

It may be feasible to develop a set of mechanisms that permit RLAN operation while adequately protecting FS receivers. Doing so, however, would require measures considerably more stringent than RLAN Group has proposed. The FWCC is willing to consult with RLAN Group on possible solutions.

Respectfully submitted,

Mitchell Lazarus

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cc (by email): Paul Margie, Counsel for Apple Inc. *et al*.

36 RLAN Group June 12 Ex Parte at 3 n.5.

37 *See* 47 C.F.R. § 15.703(i).

38 The 1 dB exclusion zone for most FS antennas (10 feet or smaller) is less than 0.5 square kilometers.

<u>ATTACHMENT 1</u>

FWCC Simulation Results

City	Number of Paths	Fade Margin Reduction > 1 dB	Fade Margin Reduction ≥ 10 dB	Fade Margin Reduction ≥ 20 dB	Fade Margin Reduction ≥ 25 dB	Fade Margin Reduction ≥ 30 dB	Fade Margin Reduction ≥ 40 dB
Chicago	**492**	4.055	0.921	0.254	0.142	0.073	0.014
Houston	**838**	4.115	0.968	0.247	0.129	0.072	0.025
Los Angeles	**513**	4.004	0.906	0.271	0.144	0.078	0.018
New York City	**452**	4.126	0.951	0.283	0.159	0.077	0.018
Phoenix	**231**	4.130	1.039	0.264	0.134	0.065	0.017
San Francisco	**301**	4.120	0.947	0.262	0.136	0.086	0.013
Seattle	**266**	4.162	0.966	0.237	0.135	0.075	0.008
Washington DC	**705**	4.051	0.957	0.255	0.142	0.067	0.020
Average	**475**	4.095	0.957	0.259	0.140	0.074	0.017

Table A

Average Number of RLAN Interference Cases per Receiver

These results use RLAN powers and distributions from RKF Study at 18, Table 3-4 and the methodology described in Kizer Analysis and summarized in Letter from Cheng-yi Liu and Mitchell Lazarus to Marlene H. Dortch, Secretary, FCC at 6-8 (filed March 13, 2018).

Attachment 2

Example of an Indoor RLAN in front of an FS Receiver
by George Kizer

We assume an indoor RLAN operating at a power of 22.9 dBm EIRP. This is a weighted average of indoor RLANs, computed as follows from RLAN Group data:[a]

Indoor device type	EIRP (dBm) from RKF Study at 18 Table 3-4	Weight from RKF Study at 23 Table 3-7	Product of left two columns
Enterprise AP	23.6	0.0263	0.62
Consumer AP	23.8	0.6631	15.78
Gaming router	35.3	0.0474	1.67
Client	18.5	0.2632	4.87
TOTAL (weighted average)		1.0000	**22.94**

We assume the RLAN is located inside a building at least one first Fresnel zone away from the boresight signal of a victim Fixed Service (FS) microwave receiver (a typical FS path design requirement). The RLAN is assumed to be one kilometer away from the FS receiver.

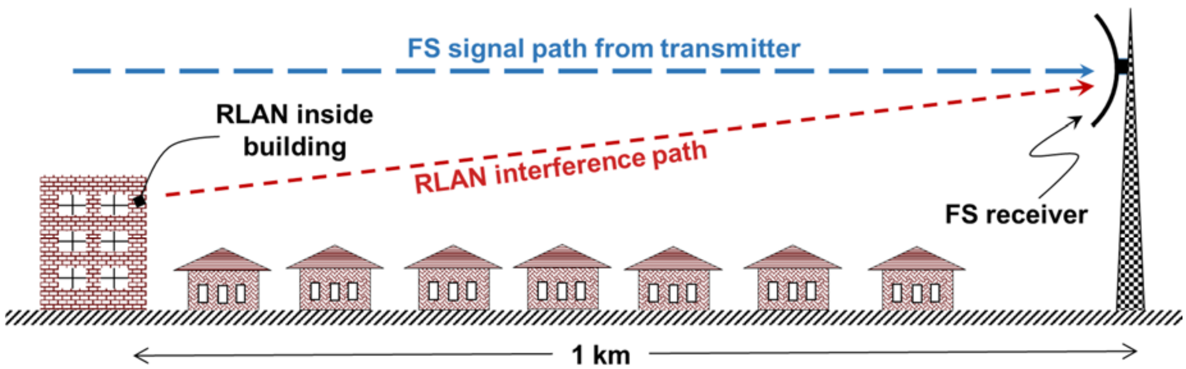

Figure 1: RLAN interference from inside building (not to scale)

We assume the FS receiver is a 30 MHz receiver with 5 dB noise figure. The receiver front end noise (N) will be -94 dBm.[b] The RLAN Group (and national and international) criterion for acceptable 1 dB threshold degradation is -100 dBm (I/N = -6 dB) interference into the FS receiver.[c]

We will assume the smallest (lowest gain) size antenna usually employed with wideband FS receivers: 6 feet (the smallest category A antenna at lower 6 GHz).

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[a] Data from RKF Study at 18, 23, Tables 3-4, 3-7.

[b] Kizer, G., *Digital Microwave Communication*. Hoboken: Wiley and Sons, 2013, page 52, Equation (3.10).

[c] RKF Study at 5, 6 and 11. See also footnote 10 in text.

Since the building and RLAN are only a few first Fresnel zones away from the boresight victim radio path, the antenna sidelobe rejection is negligible. (The drawing exaggerates the angle of the interference path into the antenna.) The antenna gain toward the RLAN is essentially the same as toward the far end FS transmitter (38.8 dBi for a commercial UHX6 antenna).

We assume the RLAN operating channel includes the channel of the victim FS receiver. The weighted average of the RLAN bandwidths is 94 MHz.[d] The effective RLAN transmitter EIRP within the victim FS receiver passband is 22.9 dBm + 10 $\log_{10}(30/94)$ = 17.9 dBm.

RLAN Group suggests indoor RLAN antennas should be treated as having an isotropic radiating pattern.[e] Statistically we should impose a 3 dB polarization coupling loss. The effective RLAN transmitter EIRP is now reduced to 17.9 dBm - 3 dB = 14.9 dBm.

We will impose a building radio wave penetration loss of 20 dB (discussed in text).[f]

If we assume the center operating frequency of lower 6 GHz (6.175 GHz), we have enough information to calculate the interfering signal level at the victim receiver:

> Victim FS Receiver Received Signal Level from Interfering Transmitter (I)
> = Transmitter EIRP - Building Penetration Loss - Free Space Loss + Receive Antenna Gain
> = 14.9 dBm - 20 dB - [92.45 + 20 $\log_{10}$(6.175 GHz) + 20 $\log_{10}$(1 km)] dB + 38.8 dBi
> = -74.6 dBm

The receiver front end noise N is -94 dBm. The expected interference I is -74.6 dBm. The victim FS receiver will experience a Fade Margin Reduction (FMR)[g] of $\{10 \log_{10} [10^{N/10} + 10^{I/10}]\} - N = \{10 \log_{10} [10^{-94/10} + 10^{-74.6/10}]\} - (-94) = 19.4$ dB.

This Fade Margin Reduction of 19.4 dB far exceeds the 1 dB RKF limit and will cause FS link failure during even moderate fades.

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[d] RKF Study at 24, Table 3-9.

[e] RKF Study at 17, third paragraph.

[f] RKF Study at 1 ITU-R Report P.2346-0, *Compilation of Measurement Data Relating to Building Entry Loss*, Geneva: International Telecommunication Union, Radiocommunication Sector (May 2015); Furgin, G., Rappaport, T. S. and Xu, H., *Measurements and Models for Radio Path Loss and Penetration Loss in and Around Homes and Trees at 5.85 GHz*, IEEE Transactions on Communications at 1484-95 (Nov. 1998); Loew, L. H., Lo, Y., Laflin, M. G. and Pol, E. E., *Building Penetration Measurements from Low-height Base Stations At 912, 1920, and 5990 MHz*, NTIA Report 95-325, Boulder: National Telecommunications and Information Administration, Institute for Telecommunications Sciences (Sept. 1995).

[g] Kizer Study, page 10, equation (5).