



Review of TCB PAG Submissions

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Note: The views expressed in this presentation are those of the authors and may not necessarily represent the views of the Federal Communications Commission.



Overview

- Currently, there are forty categories on the PAG list.
- Thus, the FCC still has an extensive amount of applications to process.
- The quicker an application can be reviewed and approved, the better it is for stakeholders involved.
- Thus, having an application with minimal (or no) mistakes or shortcomings is the goal.
- This session we will be looking at some items specific to PAG item UN6GHZ.



Contention Based Protocol for 6 GHz

- Clarification of narrowest and widest bandwidth. (Especially pertaining to UNII-6)
- For review; from KDB 987594.
 - KDB 987594 D03 U-NII 6GHz Q&A v01
 - Q9. If a device operates in U-NII bands 5, 6, 7 and 8, does the test lab need to test at least three channels (L, M & H) in each sub-band of operation?
 - A9. Yes. LMH in band 5, LMH in band 6, and so forth. Exception exists for the contention-based protocol test where only one channel in each supported sub-band needs to be tested. The narrowest and widest bandwidth in each channel shall be measured.

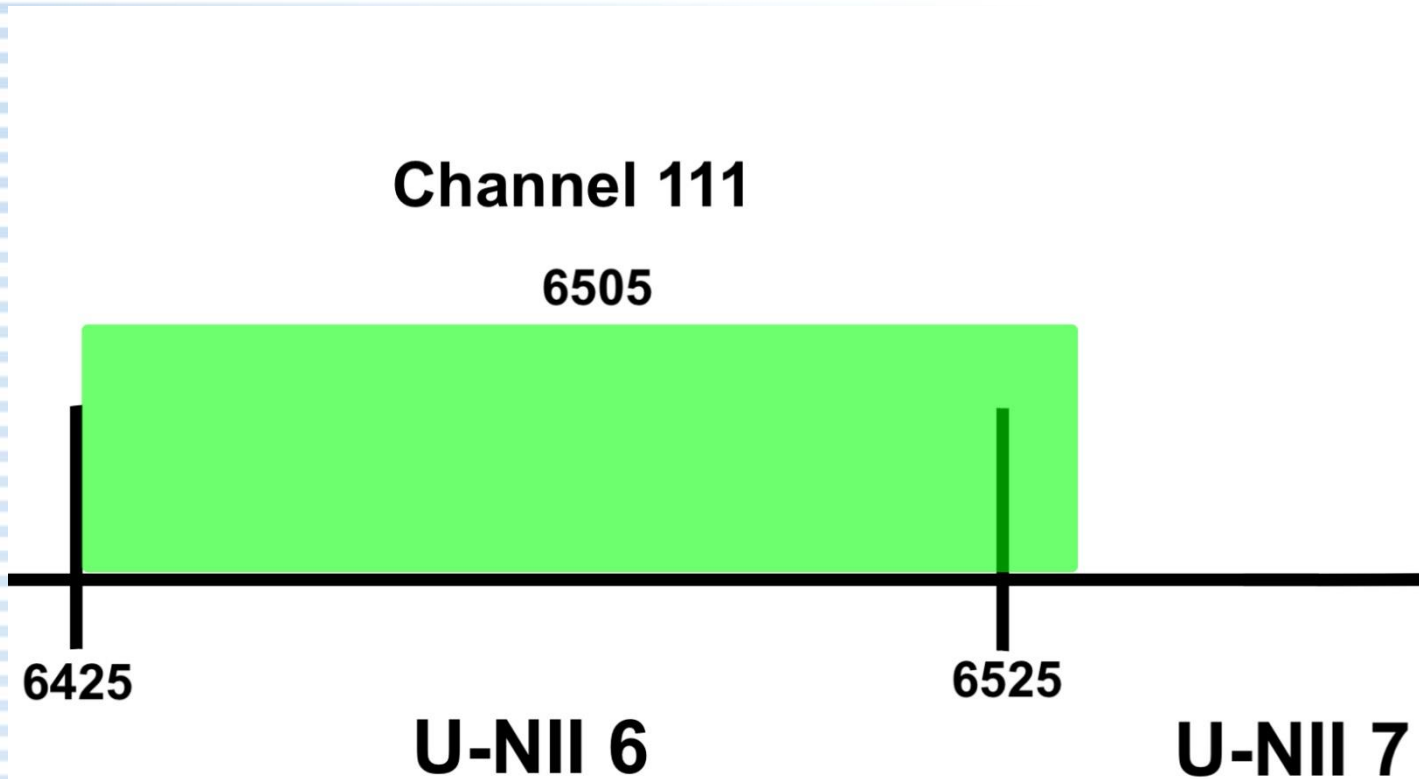


Contention Based Protocol for 6 GHz

- The narrowest and the widest bandwidths are those signals whose center frequency fall within the sub-band of investigation regardless of whether they are fully contained within that sub-band.
- Most 6 GHz devices have channel bandwidths from 20 MHz up to 160 MHz.
- The sub-band U-NII 6 6.425 – 6.525 GHz.



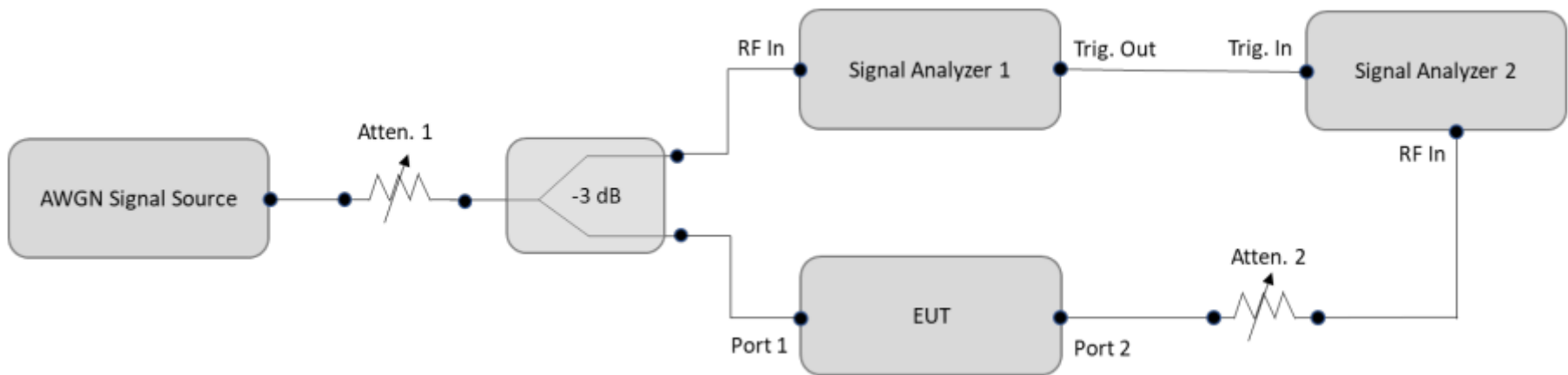
Contention Based Protocol for 6 GHz





Contention Based Protocol for 6 GHz

- Guidance on testing MIMO systems using the conducted method with similar and dissimilar paths and antennas.
 - KDB 987594 has a simplified diagram.
 - Most devices operating in 6 GHz are MIMO.





Contention Based Protocol for 6 GHz

- If the antenna gains and the path loss are the same.
 - You can drive one representative port.
 - You can drive multiple ports.
 - Document what you did in the test report.
- If the antenna gains are different.
 - Minimally test the path with the lowest gain antenna as this will be the least sensitive to detecting an incumbent signal.
 - Document what you did in the test report.



Contention Based Protocol for 6 GHz

- Performing CBP testing using the conducted test method. For review; from KDB 987594 D02 v01r01.
 - Set the AWGN signal power to an extremely low level (more than 20 dB below the -62 dBm threshold). Connect the AWGN signal source, via a 3-dB splitter, to the signal analyzer 1 and the EUT as shown in figure 2.
 - Monitor the signal analyzer 2 to verify if the AWGN signal has been detected and the EUT has ceased transmission. If the EUT continues to transmit, then incrementally increase the AWGN signal power level until the EUT stops transmitting.
- Though not explicitly stated, the reason for this is to see the level of sensitivity the device has, and this should be documented.
- Additionally, this is the level to be used to test for the 90% detection rate.



Contention Based Protocol for 6 GHz

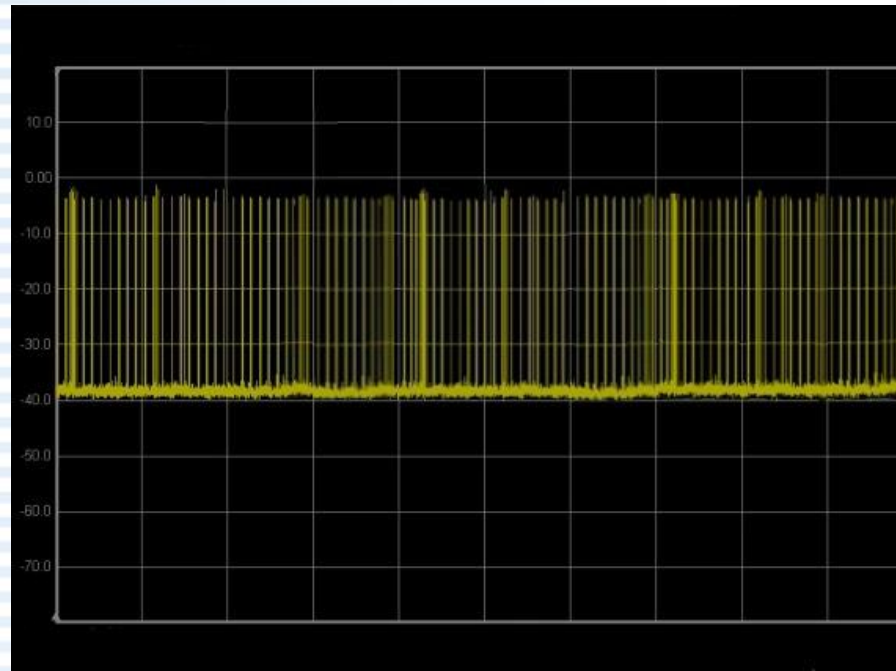
- Guidance in accordance with KDB 987594 D03 Q&A v01.
 - Q15. During contention-based protocol testing, once the EUT has detected an AWGN signal and ceased transmission is it allowed to send intermittent control signals?
 - A15. No. Signals of any kind are not allowed to be sent
 - Q16. What data is required to be submitted for contention-based protocol testing?
 - A16. In addition to showing that the device stops transmitting at the required threshold we would also like to see the AWGN signal levels that the device starts transmitting again. That is, what is the lowest AWGN signal level that the EUT detects and determines the medium is busy.



Contention Based Protocol for 6 GHz

● Normal Operation

- The level at which there is no apparent detection and the operation of the EUT is still considered optimal.

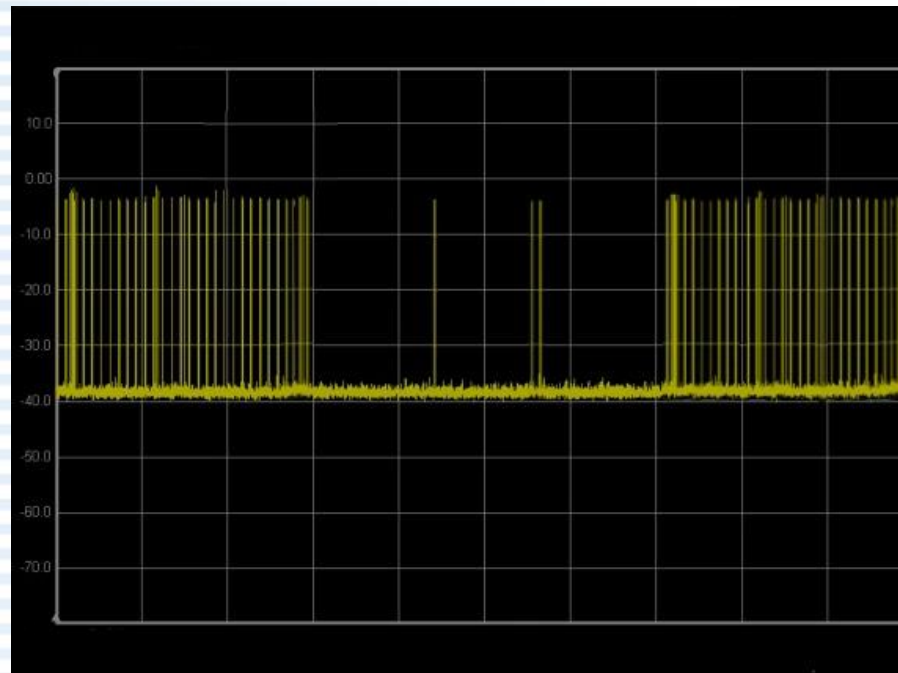




Contention Based Protocol for 6 GHz

● Minimal Operation

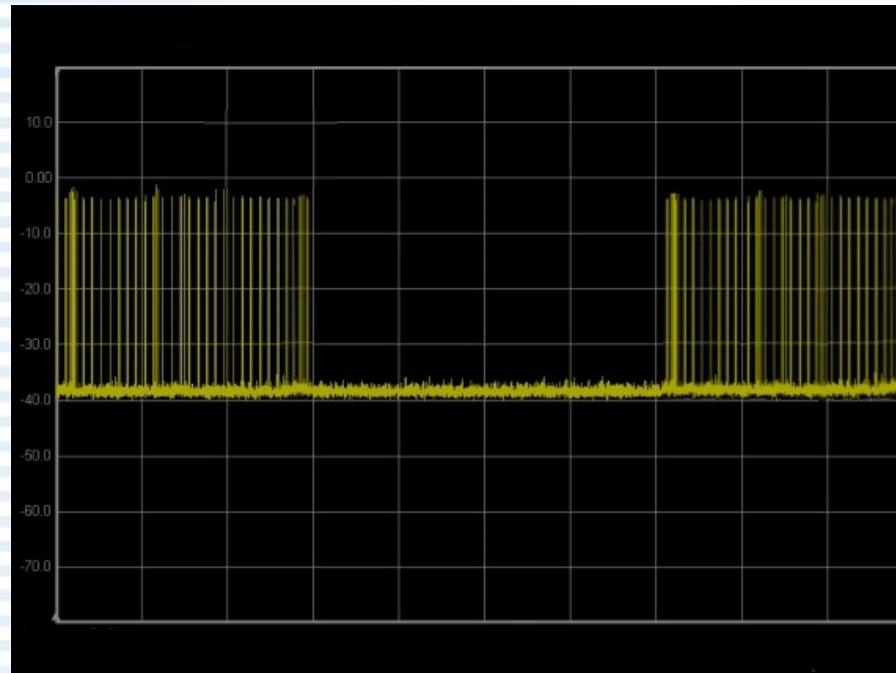
- The AWGN level at which the system begins to trigger the transmission switch-off, albeit not being kept off consistently.





Contention Based Protocol for 6 GHz

- Ceased
 - The level at which no transmission is detected, consistently for a minimum period of 10 seconds.





Contention Based Protocol for 6 GHz

- Guidance for presenting tabular data.
 - KDB 987594 does not give a “hard and fast” rule as to how data must be presented. Labs have flexibility.
 - However, in the interest of making it easier to review and process these PAGs, we do suggest a general guideline.
 - From KDB 987594 D02 v01r01
 - “The -62 dBm (or lower) threshold is referenced to a 0 dBi antenna gain.”



Contention Based Protocol for 6 GHz

● Values in this table are hypothetical.

Injected (AWGN) Power (dBm)	Antenna Gain (dBi)	Path Loss (dB)	Adjusted Power (dBm)	Detection Limit (dBm)	EUT Tx Status
-65.5	3	0.2	-68.3	-62	Ceased
-70.4	3	0.2	-73.2	-62	Minimal
-80.0	3	0.2	-82.8	-62	Normal

Actual power of AWGN injected into the antenna port.

Antenna gain of a single chain.

Adjusted Power = Injected AWGN Power - Antenna Gain + Path Loss



Contention Based Protocol for 6 GHz

- Use a separate table for the actual detection probability evaluation.

Mode	UNII Band	Center Frequency (MHz)	Incumbent Frequency (MHz)	Injected AWGN (dBm)	1	2	3	4	5	6	7	8	9	10	Detection Probability (%)	Limit (%)	
802.11ax -HE160	5	6185	6110	-68	√	√	√	√	√	√	√	√	√	√	100	90	
			6185	-67	√	√	√	√	√	√	√	√	√	√	√	100	90
			6260	-67	√	√	x	√	√	√	√	√	√	√	√	90	90
	6	6505	6430	-70	√	√	√	√	√	√	√	√	√	√	√	100	90
			6505	-71	√	√	√	√	√	√	x	√	√	√	√	90	90
			6580	-70	√	√	√	√	√	√	√	√	√	√	√	100	90
	7	6665	6590	-65	√	√	√	√	√	√	√	√	x	√	√	90	90
			6665	-66	√	√	√	√	√	√	√	√	√	√	√	100	90
			6740	-65	√	√	√	√	√	√	√	√	√	√	√	100	90
	8	6985	6910	-71	√	√	√	√	√	√	√	√	√	√	√	100	90
			6985	-70	√	x	√	√	√	√	√	√	√	√	√	90	90
			7060	-72	√	√	√	√	√	√	√	√	√	√	√	100	90



In-Band Emissions Mask

- From KDB 987594 D03 Q&A v01
 - Q13. Can the smallest 26 dB bandwidth be used for all channels with the same nominal bandwidth when performing the mask measurement?
 - A13. Yes. As an example, for a 20 MHz nominal bandwidth the smallest measured 26 dB bandwidth may be used for all 20 MHz channels. As a practical matter, the nominal bandwidth may also be used provided it can be shown that the 26 dB bandwidth is always $>$ nominal bandwidth.
 - If the technology supports both full RU and partial RU, both cases must be evaluated for In-Band Mask.
 - The same mask “built” for the full RU signal may be used for the partial RU configuration.



In-Band Emissions Mask

- From KDB 987594 D02 EMC Measurement v01r01
 - Measure the power spectral density (which will be used for emissions mask reference) using the following procedure:
 - a) Set the span to encompass the entire 26 dB EBW of the signal.
 - b) Set RBW = same RBW used for 26 dB EBW measurement.
 - c) Set VBW $\geq 3 \times$ RBW
 - Many labs are arbitrarily setting the RBW to 1 MHz.
 - Any deviation from an approved or recommended test method needs to be explained and justified.



Checklist for 6 GHz KDB 987594

- PAG item UN6GHZ Checklist to be included into KDB 987594
- This is to assist the Labs and TCBs in **reviewing test reports prior** to submitting for PAG approval.
- When UN6GHZ is no longer a PAG item, the TCBs and Labs will still be able to use the list to complete their own reviews.



Checklist for 6 GHz KDB 987594

● 1. Antennas

- 1.1 Information for all the antennas, i.e., type, gain and relative positions within host, must be included in the filing
- 1.2 Show how the (aggregate, if applicable) antenna gain was computed/measured (as in TCB Workshop Presentation Aggregate Antenna Gain Review, April 2021). Provide equation(s) used to calculate Directional Gain and provide example calculation showing how the DG was calculated with the antenna gain of individual antennas. Provide details (references or attached documents) on how the individual antenna gains were derived, i.e., declared by the host manufacturer, based on data sheet, or measured. Since the CBP needs to detect a small signal, the worst-case scenario to consider is when the receiver has the lowest antenna gain.
- 1.3 For conducted test in MIMO cases, show that the testing was done for that path that has the lowest antenna gain.



Checklist for 6 GHz KDB 987594

- 2. Contention Based Protocol (CBP)
 - 2.1 CBP testing shall be performed on one channel in each sub-band of operation for both narrowest and widest bandwidths
 - 2.2 Use three separate 10 MHz AWGN signals when testing a 160 MHz channel. The simulated incumbent signal must be a 10 MHz wide AWGN signal
 - 2.3 Report lowest AWGN signal detectable by EUT
 - 2.4 Verify that the testing was performed with the AWGN signal set to lowest level (for example, -100 dBm) and increased until the EUT detects and stops transmitting.
 - 2.5 If conducted measurements are used, the detection threshold needs to be corrected to refer to a 0 dBi gain antenna and include all the applicable losses (cables, etc.). For instance, the report should show (at least):
Detection Level = Injected AWGN Power (dBm) – Antenna Gain (dBi) + Path Loss (dB)



Checklist for 6 GHz KDB 987594

- 2. Contention Based Protocol (CBP) Cont'd
 - 2.6 Include plots showing EUT has stopped transmitting after detection of AWGN signal.
 - 2.7 Describe whether channel puncturing and/or bandwidth reduction mechanisms supported. The report needs to include a plot as an example for at least one of the AWGN signals used.
 - 2.8 If radiated testing is used, show that spot-checks were done to identify which side of the EUT has the lowest sensitivity to the incumbent signal detection, and that side was indeed chosen for the test.



Checklist for 6 GHz KDB 987594

● 3. Client Device Limitations

- 3.1 Client device (per definition in 15.202) is limited to indoor locations, does not connect directly to the internet nor to other clients
- 3.2 Requires attestation (as form 731 exhibit) stating that the device can only operate under the control of a low-power indoor access point and subordinate.
- 3.3 No vehicular use, except large aircrafts above 10000 ft.
- 3.4 Transmit Power Control (TPC) required for client devices connected to Standard Power Access Points, excluding Fixed Client devices
- 3.5 Show/justify enclosure is not weatherized for Subordinate and APs.



Checklist for 6 GHz KDB 987594

● 4. Emission Mask

- 4.1 Power spectral density suppression comply with 47 CFR § 15.407(6).
- 4.2 If EUT supports OFDMA discuss testing of partial Resource Unit (RU) configurations. In any case the shape of the mask shall be based on full RU.
- 4.3 OOB limits only apply outside of the 5.925 – 7.125 GHz band. All in-band emissions need to meet the channel mask. In case a higher RBW for the in-Band Emissions Mask is used (i.e., a more conservative case) that should be noted.

● 5. Filing

- 5.1 99% of the occupied bandwidth must be contained within all the U-NII sub bands authorized for that equipment class



Checklist for 6 GHz KDB 987594

● 6. Hearing Aid Compatibility (HAC)

- 6.1 Confirm that VoLTE cannot be transported over 5G NR sub 6 GHz. If so, must state that in the OTT declaration of pre-install of OTT voice service and test report.
- 6.2 Manufacture must provide an attestation (cover letter) confirming that the results using ABM1 values obtained from VoLTE connections over LTE bands and ABM2 values for 5G sub 6 GHz connections over the same bands provide a reasonable representation of the HAC rating over the 5G sub 6 GHz connections.

● 7. Labelling

- 7.1 Label showing indoor only for Subordinate and APs.
- 7.2 E-labelling may be acceptable if proper justification is provided

● 8. Modular Certifications (when applicable)

- 8.1 Modular approval letter to be uploaded with the application
- 8.2 No subordinate devices can be modules
- 8.3 Show notification for the host manufacturer about referencing KDB 996369 D04 Module Integration Guide



Checklist for 6 GHz KDB 987594

● 9. RF Exposure

- 9.1 Demonstrate applicable classification (portable/mobile/fixed) in reference to worst-case scenario use cases
- 9.2 Address $f > 6$ GHz RF exposure via interim procedure in Oct 2020 TCB Workshop – 5.4 (slide 30)
- 9.3 Address all applicable simultaneous transmission conditions using the compliance condition $TER \leq 1$, where TER (total exposure ratio) in this context is defined as

$$TER = \sum_{k=1}^{N_S} \left(\frac{SAR_k}{SAR_{lim}} \right) + \sum_{k=1}^{N_f} \left(\frac{MPE_{field, k}}{MPE_{field, lim}} \right)^2 + \sum_{k=1}^{N_{PD}} \left(\frac{MPE_{PD, k}}{MPE_{PD, lim}} \right)$$

with N_S , N_f , and N_{PD} referring to sources requiring SAR, field-MPE, or PD-MPE, respectively, k referring to measured or estimated values for the source k , and “*lim*” to the corresponding applicable compliance limit



Checklist for 6 GHz KDB 987594

- 10. Security
 - 10.1 Provide specific exhibit with device security description is required (complying with 15.407(i))
- 11. Spurious Emissions
 - 11.1 Show that measurements are made at the prescribed antenna heights, per KDB 987594, including measurements along all three axes, as in ANSI C63.10



Miscellaneous Concerns

- Clean up your 6 GHz report templates.
 - Most 6 GHz report templates are repurposed UNII 1 – 3
 - Finding references having nothing to do with UNII 5 - 8
- Differences in interpretation of rules between TCB and Lab can lead to confusing application.
 - A Lab and a TCB may have differing opinions
 - Submit a KDB inquiry before submitting a PAG
- A large number of Class II Permissive Change Letters are still not descriptive enough.
 - These letters should be a complete narrative
 - There should be no need to glean from other exhibits



Key Takeaways

- Clear, Concise, and Complete applications greatly facilitate the PAG process.
- Attention to detail with regards to the test reports is a **MUST!**



Questions?

Thank You!