Incumbent Fixed Service Data in the U.S. U-NII 5 & 7 Bands

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Incumbent Fixed Service Data in the U.S. U-NII 5 & 7 Bands

1 Background

With the FCC 6 GHz Report and Order (R&O), FCC 20-51[1], the FCC requires that the Automated Frequency Coordination (AFC) system rely on the Universal Licensing System (ULS) for fixed microwave link data when calculating and establishing the exclusion zones to protect those microwave links from harmful interference in the 5.925-6.425 GHz and 6.525-6.875 GHz bands. This document provides information on general data quality issues with the ULS and identifies some of the missing data that will be pertinent to future discussion on AFC system implementation.

1.1 FCC Report and Order FCC 20-51

The R&O establishes ULS as the data source for incumbent fixed microwave link data. From paragraph 30 (underlining added):

"Use of ULS for information on incumbent operations. As proposed in the Notice, we will require that the AFC system rely on the Commission's Universal Licensing System (ULS) for fixed microwave link data when calculating and establishing the exclusion zones to protect those microwave links from harmful interference. The Universal Licensing System is the official licensing database for microwave links in the U-NII-5 and U-NII-7 bands and contains extensive technical data for site-based licenses including transmitter and receiver locations, frequencies, bandwidths, polarizations, transmitter EIRP, antenna height, and the make and model of the antenna and equipment used. Thus, the Universal Licensing System contains the information necessary for AFC systems to protect fixed service links. Several commenters, including APCO, the Dynamic Spectrum Alliance, the Open Technology Institute et al., Apple, Broadcom et al., and Wi-Fi Alliance support using the ULS system for this purpose. To ensure that AFC systems have the most recent information on fixed service links, we will require AFC systems to download the database on a daily basis."

Paragraph 32 goes on to clarify that licensed, pending, and temporary fixed stations should all be protected by the AFC system (underlining added):

"Microwave links may begin operation prior to obtaining a license so long as certain criteria are met, such as completing successful frequency coordination and filing an application that appears in the Universal Licensing System as pending. Because such a filing may indicate that a new station is operational, or soon will be, we will require the AFC system to protect pending as well as granted facilities. In addition, temporary fixed microwave links may be authorized by a blanket authorization, in which case the licensee is not required to obtain approval from the Commission prior to operating at specific locations or report the technical details of their operation to the Commission. Because the AFC system must have knowledge of the location of temporary fixed

[1] https://ecfsapi.fcc.gov/file/0424167164769/FCC-20-51A1.pdf

links in order to protect them from harmful interference, we will require the operators of temporary fixed stations to register the details of their operations (transmitter and receiver location, antenna height, antenna azimuth, antenna make and model, etc.) in the Universal Licensing System prior to transmission if they desire to be protected from potentially receiving harmful interference from standard-power access points in the U-NII5 and U-NII-7 bands. Because temporary fixed links are not mobile and intended to operate at a specified location for up to a year, we do not believe this registration requirement poses a significant burden on licensees."

2 The ULS and how to Access it

2.1 The ULS

The ULS is used by the FCC to authorize licensed incumbent fixed microwave transmitters in the 6 GHz bands in which unlicensed devices are subject to direction by an AFC system: 5.925-6.425 GHz and 6.525-6.875 GHz. The ULS contains data on several other bands and several radio services under the FCC's Wireless Telecommunications Bureau. The AFC system discussion is concerned with the Microwave Service (47 CFR Parts 74 and 101).

The ULS is primarily a regulatory database and lacks comprehensive technical data required to perform accurate interference analyses by an AFC system. Data on microwave systems is typically entered into the ULS by filing an application after the successful completion of the Part 101 Frequency Coordination Process. The user interface for ULS can be found at https://www.fcc.gov/wireless/systems-utilities/universal-licensing-system.

2.2 Accessing ULS Data

ULS data is freely available to anyone via three mechanisms:

1. A user web interface at https://www.fcc.gov/wireless/systems-utilities/universal-licensing-system. From this page, there is a License Search and an Application Search link. The Advanced search can be used to limit the frequency range, and any other criteria. The licenses and applications will be displayed on an easy-to-read web page.
2. Email request for data (text file). On the query results of the user web interface, there is a Query Download link where an e-mail address can be provided. A link to the download, once it is prepared, will be sent in the e-mail.
    a. This method often has issues, especially with zipped files over 5 MB.
    b. While an e-mail with the subject, License Search Query Download Confirmation is provided, the download file is frequently not created.
    c. The main ULS page, https://www.fcc.gov/wireless/systems-utilities/universal-licensing-system, provides system alerts, like that shown in Figure 1 below:

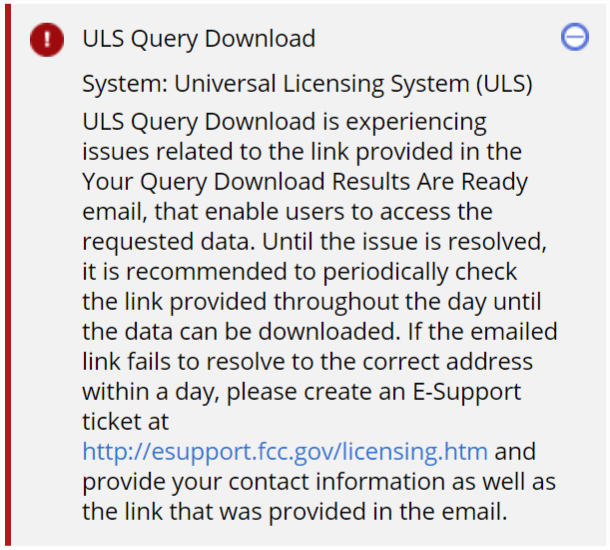

Figure 1: Example ULS Query Download Error Message

3. Weekly and daily files containing all fixed microwave bands is posted via FTP at:
    a. ftp://wirelessftp.fcc.gov/pub/uls/complete/
    b. ftp://wirelessftp.fcc.gov/pub/uls/daily/
    c. The FCC provides more information about the downloads at https://www.fcc.gov/wireless/data/public-access-files-database-downloads
    d. Note that these downloads will need to be filtered to just the U-NII-5 and U-NII-7 bands.

ULS data is arranged in a series of over 80 different tables, none of which contains header information. In addition, when the data is made available through the e-mail/download process, it is provided as a single delimited file. An example of a typical microwave data record is provided in Figure 2.

The ULS data that is relevant to 6 GHz fixed service incumbents is the “Microwave – 47 CFR Parts 74 and 101, and 3650-3700 MHz (NN)” database.

```
HD|||MW000CF001|||CF|||||C|N|N|N|N|N|N|N|N|N|N|Y|Y|Y|N|N|N|N|Robert|L|Smith|Sr|President|||||||||||||
AD|||MW000CF001|NE||N|N|||||||||Y|1|N|||||Y||||
EN|||MW000CF001||CL||MW Law LLC|||||2024184563|2024187799||2100 M Street|Washington|DC|20004||||
EN|||MW000CF001||O|L00065142|||||||||||||||||
MW|||MW000CF001||N|||F||FX0|N
EN|||MW000CF001||L|456789122|EBF Inc.|||||2027287100|2027287722||1720 K Street|Washington |DC|20006||000||
PS|||MW000CF001|2||Arlington
CP|||MW000CF001||A|1|800 North Ave|New York|NY|2125554646|Queens
LO|||MW000CF001||A|F|T|1|||601 Cleveland St|Clearwater|Pinellas|FL||||10.7|27|57|54.9|N|82|47|54.3|W|||||||||
N|||36.6|38.8|B||Tamp003|||||
LO|||MW000CF001||A|F|R|2|||||||||9.1|27|57|57.9|N|82|47|54.3|W|||||||||||||||Tam0014024|||||
LO|||MW000CF001||A|F|R|3|||||||||22.6|27|57|40|N|82|46|33.3|W|||||||||||||||Tam0013938|||||
LO|||MW000CF001||A|F|R|4|||||||||11.3|27|57|57.9|N|82|47|27.9|W|||||||||||||||Tam0013861|||||
AN|||MW000CF001||A|1|1||T||38.1|Radio Waves Inc|HPLP1.5-23|3.8|V|2.1|37.8|0||||||||||1|||1|
AN|||MW000CF001||A|1|2||R||51.5|Radio Waves Inc|HPLP1.5-23||||37.8||||||||||2|||1|
AN|||MW000CF001||A|2|1||T||38.1|Radio Waves Inc|HPLP1.5-23|0|V|2.1|37.8|101.7||||||||||1|||2|
AN|||MW000CF001||A|1|3||R||25.6|Radio Waves Inc|HPLP1.5-23||||37.8||||||||||3|||2|
AN|||MW000CF001||A|3|1||T||38.1|Radio Waves Inc|HPLP1.5-23|1.5|V|2.1|37.8|82.7||||||||||1|||3|
AN|||MW000CF001||A|1|4||R||55.8|Radio Waves Inc|HPLP1.5-23||||37.8||||||||||4|||3|
FR|||MW000CF001||A|1|1|FX0||22725|||||||0.001|||29.8|Digital Microwave Corp||N||||||1
FR|||MW000CF001||A|1|2|FX0||22525|||||||0.001|||54.8|Digital Microwave Corp||N||||||2
FR|||MW000CF001||A|1|3|FX0||22925|||||||0.001|||37.8|Digital Microwave Corp||N||||||3
EM|||MW000CF001||1|1|22725|A|10M0F7W|12352|4FSK||1
EM|||MW000CF001||1|2|22525|A|10M0F7W|12352|4FSK||2
EM|||MW000CF001||1|3|22925|A|10M0F7W|12352|4FSK||3
PA|||MW000CF001||A|1|1|1|2|1||PP|N||N|
PA|||MW000CF001||A|2|1|2|3|1||PP|N||N|
PA|||MW000CF001||A|3|1|3|4|1||PP|N||N|
```

Figure 2: Example of ULS ASCII Batch File

3 Problems with ULS Data

The AFC system will need to interface with the ULS to obtain data on technical configurations of incumbents' microwave systems. This retrieval must occur at least daily and it must include data on granted licenses as well as pending applications. [2] Granted licenses and pending applications are stored as two separate sets of data with different table structures.
The following sections outline typical ULS data issues that will need to be addressed to ensure operational effectiveness of the AFC system.

The ULS data is maintained by and the responsibility of incumbent licensees.[3] As indicated in the R&O, the FCC is expected to issue a Public Notice reminding licensees of the importance of maintaining accurate information in the ULS.

[2] See 47 CFR 15.407 (k)(8)(iv).
[3] See the R&O at ¶ 31.

3.1 Administrative Issues

An AFC system must have accurate, up to date data to sufficiently protect incumbents and make accurate calculations. If FTP data downloads are moved, changed, or delayed, AFC systems could be out of compliance with the 24-hour data accuracy rule stated in the R&O. The FCC routinely has the following administrative challenges with their FTP posting.

3.1.1 Changes to the Location of the Data Download

In April of 2019, and again in March 2020, the FCC changed the location where the ULS data was posted. This caused automated data-retrieval tools to stop functioning. While adequate notice was provided in April of 2019, no noticed was received for the March 2020 change and old data files still existed in the locations for months after the change.

3.1.2 Field Definition Changes

The FCC routinely makes changes to data definitions due to regulatory changes. In September 2015, and March 2018, the FCC made changes to the ULS data definitions with no notice. In July 2020, the FCC announced an upcoming change to the data definitions with 30 days' notice, tentatively scheduled for August 2020.
Without a header row in each file, there is no easy way to detect new definitions or implement a "fail-operate" approach to the data.

3.1.3 Data Posting Times Inconsistent

Full data downloads are typically posted on Sunday. Daily change downloads for activity on the prior day post the next day, usually late in the morning, but posting times vary frequently and times late in the afternoon have been observed.

The FCC used to provide alerts on their website when there were delays in posting the data, but there have been no alerts lately.

3.2 General notes on data quality

The nature of the ULS gives rise to the probability of data accuracy issues. First, ULS data can be entered manually with remedial error checking. This increases the likelihood of introducing errors. For example, there is a license record that shows a 500 MHz emission bandwidth, which is clearly incorrect. Cross-checking against Comsearch's frequency coordination database found that it should have been entered as 5 MHz.[4] It is also possible to find antenna models that are clearly the names of radio models.[5] There is little validation or control on critical fields and data in key fields is sometimes missing entirely.

Furthermore, by design, the FCC uses the ULS to authorize transmitters. To a much lesser extent, the FCC collects receiver information, but some key data required to protect receivers is not collected as described below. Given that interference manifests at the receiver, comprehensive and accurate receiver information will be critical for the AFC system.

[4] Comsearch is a well-known Part 101 microwave frequency coordinator who maintains a proprietary database microwave systems and configurations.
[5] For example, a cursory glance revealed 36 receivers starting with MDR, which is a radio model nomenclature.

We note that incumbent licensees are responsible for the completeness and accuracy of their license record information in the ULS. However, data inaccuracies present an inaccurate picture of spectrum usage, which can affect both incumbents and new entrants alike. Some specific examples are outlined in the following sections.

3.3 "Zombie" Paths

An example of a situation where data errors might over-protect incumbents is the concept of a "zombie path".

A "zombie path" occurs under the following scenario:

- A single call sign (unique identifier of a site license) represents a single site per licensee, but it may have multiple paths emanating from that site.
- In the case where a duplex (two-way) path is decommissioned, a licensee must remember to delete or modify both licenses for each direction of the path. That includes the receive end of the path.
- The FCC charges fees to licensees as they manage the data related to their license records. There is no fee to delete an entire call sign, but the FCC charges a fee to delete one path on a call sign that has other licensed paths. This is considered a license modification.
- Consequently, there are paths where one call sign is deleted but the call sign on the other end of the path is licensed and still shows the path to the original receive site. Since that receiver still appears on its formerly associated transmitter's license, the license record for that call sign shows a receiver that likely no longer exists.

Note that these zombie paths are generally indistinguishable from legitimate simplex (one-way) paths.

About 1200 zombie paths were found in the ULS data by using Comsearch's frequency coordination database to identify them. A call for incumbents to clean up their license data could mitigate the zombie path issue, though the underlying reason they exist would remain.

3.4 ULS Antenna Data Problems

Correct and comprehensive data on antennas is critical for the AFC system analysis and will influence spectrum availability, but ULS antenna data has many issues as discussed below.

3.4.1 Null and Missing ULS Antenna Data

Several ULS data queries were performed and the following null or missing data were found in the FCC's licensed data sets as of August 4, 2020. Note that "null" data refers to fields that exist in the ULS but are not populated, while "missing" data is information that is important for the interference calculations (e.g., antenna patterns), but the necessary field is not available in the ULS at all.

Figure 3 shows that for over 6000 data records, the information for the main receive antenna is null and that for over 200 records, the gain is null.

If the FCC prompts licensees to update their license data, this information could be largely corrected. It should be noted that there could still be nulls to deal with even if the Commission prompts licensees to update their data.

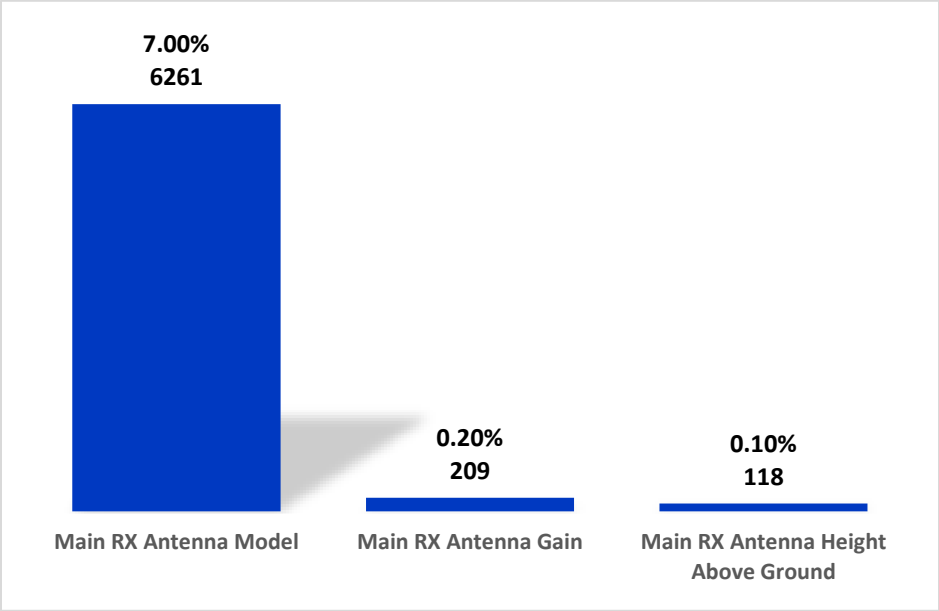

Figure 3: Null Antenna Data

Figure 4 shows that receive-only losses, diversity RX antenna models, and antenna patterns are completely missing from the ULS. From other data it has been determined that nearly a third of licenses have diversity antennas, so that is how many records are affected by the missing diversity RX antenna model data. These missing data items are discussed further in the following sections.

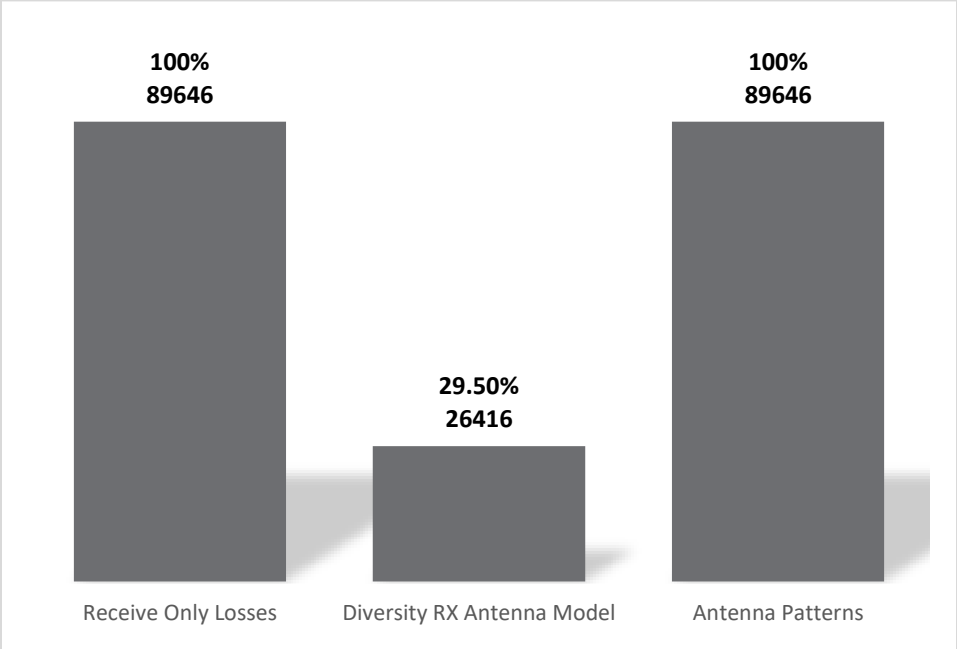

Figure 4: Missing Antenna Data[6]

3.4.1.1 Receive Only Losses

The ULS does not record receive losses (i.e., line and connector losses) between radio and antenna at all, but it is an important value for interference calculations. Without receive losses, incumbent receivers may be over-protected. It should be noted that 0 dB is typical for ODU (outdoor unit) type systems that are being deployed widely today.

3.4.1.2 Diversity RX Antenna Models

The ULS data does not record a diversity antenna model, only a gain. Given that the AFC system must protect all receivers, the question of how to address diversity antenna models is important.

Diversity antennas are relatively common in the 6 GHz bands, with almost a third of receivers having one. Diversity antennas are typically used to mitigate against multi-path fading. In an interference analysis, it could be reasonable to assume that the diversity antenna model matches the main receive antenna when the gains match. However, Table 1 shows that more than half of diversity gains do not match the main antenna gain.

Treatment of diversity antennas should be a topic of further discussion. Simply using the main receive gain as the diversity gain when the antenna models are missing is likely not a sufficient substitute.

[6] Receive-only losses are included in this chart since these losses are typically considered as part of the antenna system.

Table 1: Diversity Antenna Counts

	Count of Antenna/Polarizations	% of Total Receivers
Diversity Antenna Exists	26,416	29.5%
Diversity Gain = Main Gain	12,205	13.6%
Diversity Gain ≠ Main Gain	14,211	15.9%

3.4.1.3 Antenna Patterns and Passive Repeaters

The discussion of antenna patterns must include the treatment of passive repeaters, particularly billboard style passive repeaters.

A passive repeater is used when the two endpoints do not have line-of-sight to each other. Instead, the signal is relayed through a site that has line-of-site to both end points. There are two types of passive repeaters shown in Figures 5 and 6, billboard and back-to-back antennas. ULS data indicates that there are 1748 paths with passive repeaters (1.3% of all paths). The locations have been mapped with colors corresponding to population density in Figure 7.

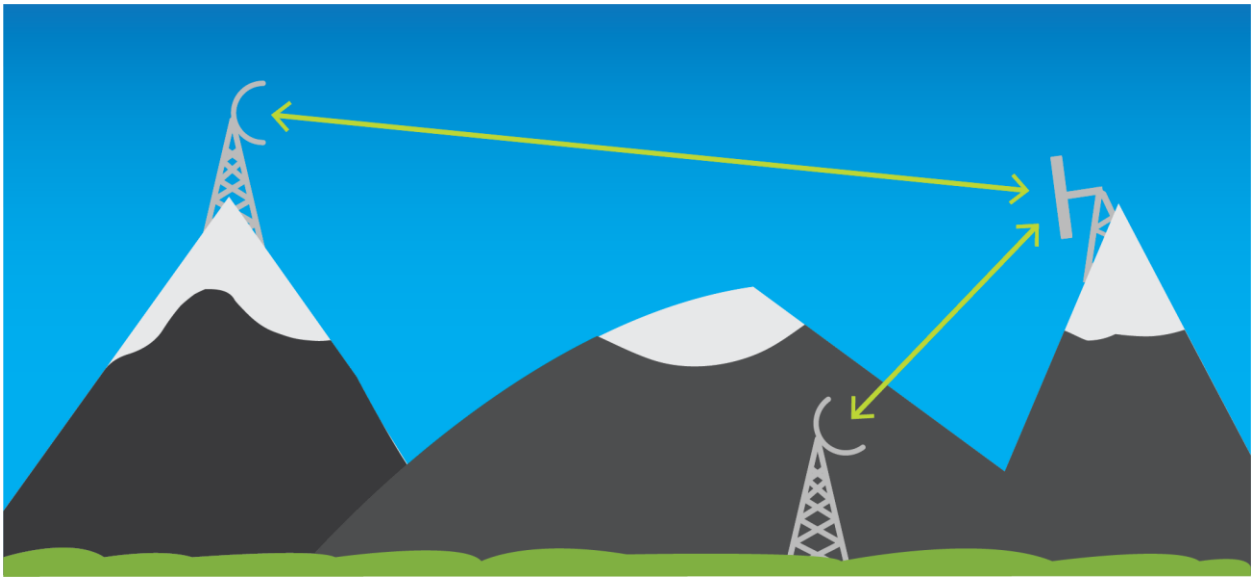

Figure 5: Billboard repeater

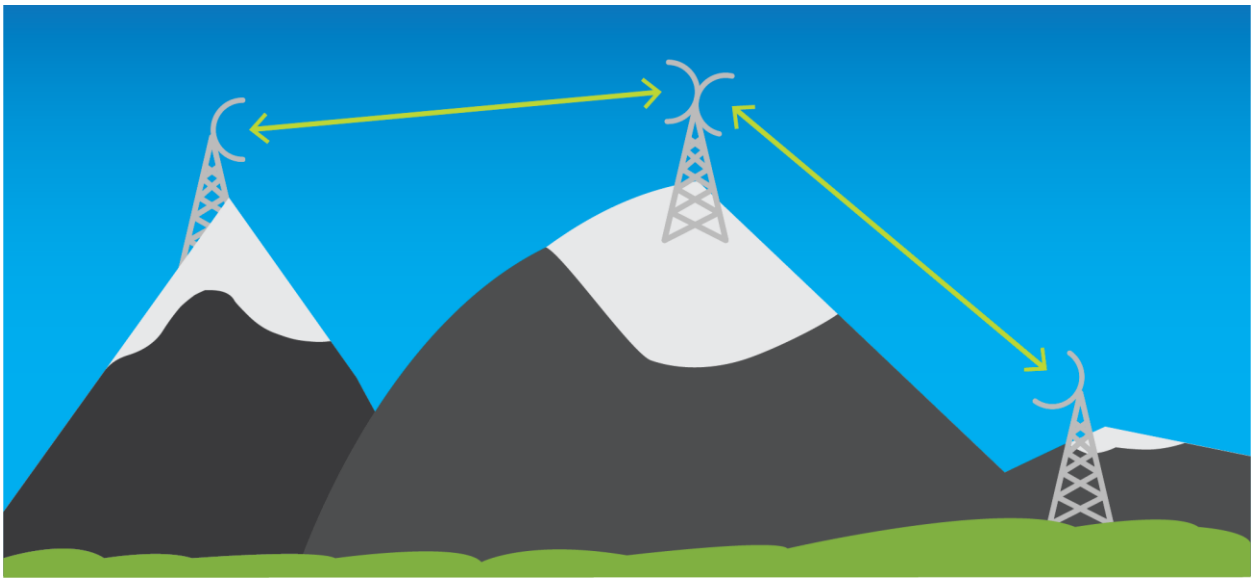

Figure 6: Back-to-Back Passive

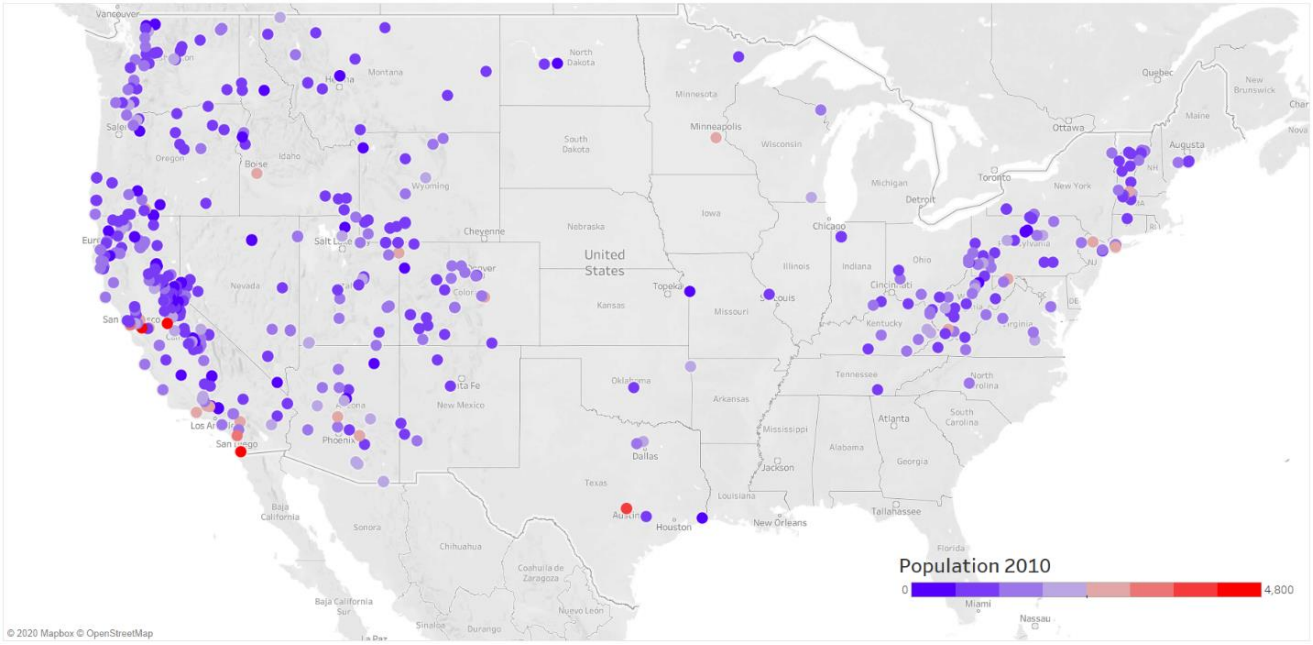

Figure 7: Passive Repeater Locations with Population

Figure 7 shows that there are significant numbers of passive repeater locations in the ULS data and a few are in highly populated areas. Going forward, discussions on addressing antenna patterns should consider how to address passive repeaters. Interference calculations will also likely need to consider these passive repeater paths.

3.4.2 Data Conflicts Within Antenna Data

In addition to null and missing data, it should be noted that some data is self-conflicting within the ULS as described below. Any treatment of antenna data in the AFC system may need to consider how to address these conflicts.

3.4.2.1 Conflicting Antenna Gains per Antenna Model

There is no data-verification in the ULS data enforcing the following:

1. The data in the Antenna Model field corresponds to an actual antenna model.
2. The data in the Antenna Gain field has any relation to the real gain for the antenna model.

Using Comsearch's antenna data and information, 2222 discrete antenna models were consolidated into 914 by simply scrubbing the data manually. A cursory glance also revealed some antenna model fields that clearly contain radio model data[7]. These types of discrepancies could likely be addressed by a cleanup of data by incumbents.

There were 55 antenna models in ULS where the gains across all licenses varied by *over 3dB* (excluding models that were clearly radios). Some varied by up to 43.9 dB.
Even if incumbents are required to correct their data, variance in gain by antenna model across the data will likely persist within the ULS, due partially to real differences in gain specifications over different antenna model versions. Discussions so far of antenna treatment in an AFC system have depended largely on antenna model, but this variance in gain per model should also be considered.

3.4.2.2 Main Antenna Gain Below FCC minimum or Unreasonably High

The spread of gain values within the ULS licensed data was investigated to see if the gains appear reasonable. Largely, gain values overall are within the expected range for FCC compliant antennas. The ULS data shows several cases where the listed gain does not meet the FCC minimum gain of 32 dBi. In all but 10 of these, an antenna model is listed, so the gain can be derived. The remaining 10 have gains between 3 and 31.9 dBi.

In addition, there are cases with very high gain which are obviously incorrect. For example, the highest gain value is 449 dBi.

A cleanup of incumbent data would help eliminate these types of gain problems. However, it should be noted that some of these data problems may persist even after a cleanup effort.

[7]For example, a cursory glance revealed 36 receivers starting with "MDR", which is a radio model nomenclature.

3.5 ULS Microwave Receiver Data Problems

Since the interference protection criteria (IPC) for microwave receivers is related only to the receiver emission bandwidth and noise floor, this is the only radio-related data required for interference analysis in an AFC system.

3.5.1 Emission Designators

The emission bandwidth of the receiver can be derived using the first 4 characters of the emission designator, which is a ULS data field.[8] For example, "28M5D7W" is a 28.5 MHz emission bandwidth.

Emission designators in the ULS data appear to be accurate to the extent they correspond to the bandwidth of the existing FCC channel plan. There is currently one with a designation of "0M00D7W" (indicating a 0 MHz bandwidth) and one has a 500 MHz bandwidth (as mentioned above).

Since there are minimal inconsistencies, emission designator seems like a relatively high-quality, trustworthy field to use in the AFC system.

3.5.2 Discrete Radio Models with Conflicting Emission Designators

The relationship between emission designators and radio models were also investigated in a similar way that gain should match to antenna models.

Out of 6108 distinct radio models, only 249 show any variation in emission bandwidth. Of those, 160 have a standard deviation in the emission bandwidth greater than 1 MHz. Upon further investigation, however, these varying emission bandwidths appear to be tied to simple matters of mistyped or incomplete radio model information, further reinforcing that emission designator is overall a high-quality field in the ULS data.

3.5.3 Missing Noise Figures

The AFC system will need to calculate the IPC as the interference-to-noise ratio (I/N). One of the components needed to calculate I/N is the Noise Level (N). As shown below, the Noise Level is determined by the combination of the receiver filter bandwidth, the atmospheric temperature and the amount of noise introduced by the receiver itself. The noise introduced by the receiver is called the Noise Figure.

The noise figure of the radio is not contained in the ULS data. Thus, the AFC system will need to establish a methodology to determine the noise figure of any given radio. Some suggestions are provided below.

3.5.3.1 Noise Figure Method

One method to calculate the Noise Level is to use the following equation:

$$N\ (dBm) = -114\ dBm + 10 * \log10\ (B_{MHz}) + NF(dB)$$

In this equation, the Bandwidth (B_{MHz}) can be determined using the emission designator in the FCC Database. As mentioned above, the radio's Noise Figure (NF) is not defined in the ULS.

[8] See 47 CFR 2.201 & 2.202

This can sometimes be determined from the radio manufacturer and model, with additional information from the manufacturer.

3.5.3.2 Threshold to Interference Method

The defined protection criteria of I/N = -6 dB correlates to a 1 dB threshold degradation of the receiver. The Threshold-to-Interference (T/I) method, defined in TIA Standard 10[9], is the power level that causes 1 dB of threshold degradation. Therefore, we can develop an equation to calculate the Noise Level from the T/I data for the radio.

N (dBm) = Threshold (dBm) – T/I (0 MHz) + 6 dB

As with the Noise Figure, T/I data is typically available from radio manufacturers in the U.S. but is not defined in the ULS.

3.5.3.3 Noise Figure Histogram

Using the T/I method to calculate Noise Figure for radios in the Comsearch database, the distribution of Noise Figures by frequency assignment and by distinct radio is shown in Figures 8 and 9. When weighted by frequency assignment, the average Noise Figure is 2.7 dB, and when looking at distinct radio models and not weighting by frequency assignment, the average Noise Figure is 3.3 dB.

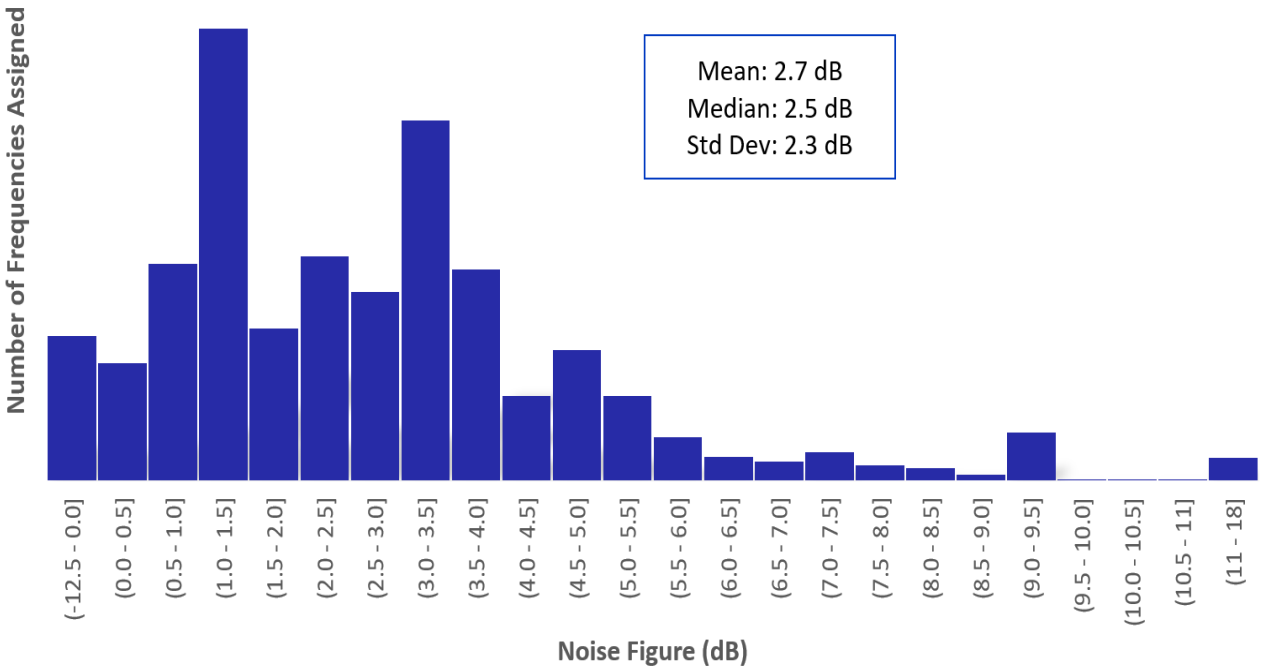

Figure 8: Noise Figure by frequency assignment using Comsearch path and radio data

[9] TIA, “Interference Criteria For Microwave Systems”, TIA-10, May 2019.

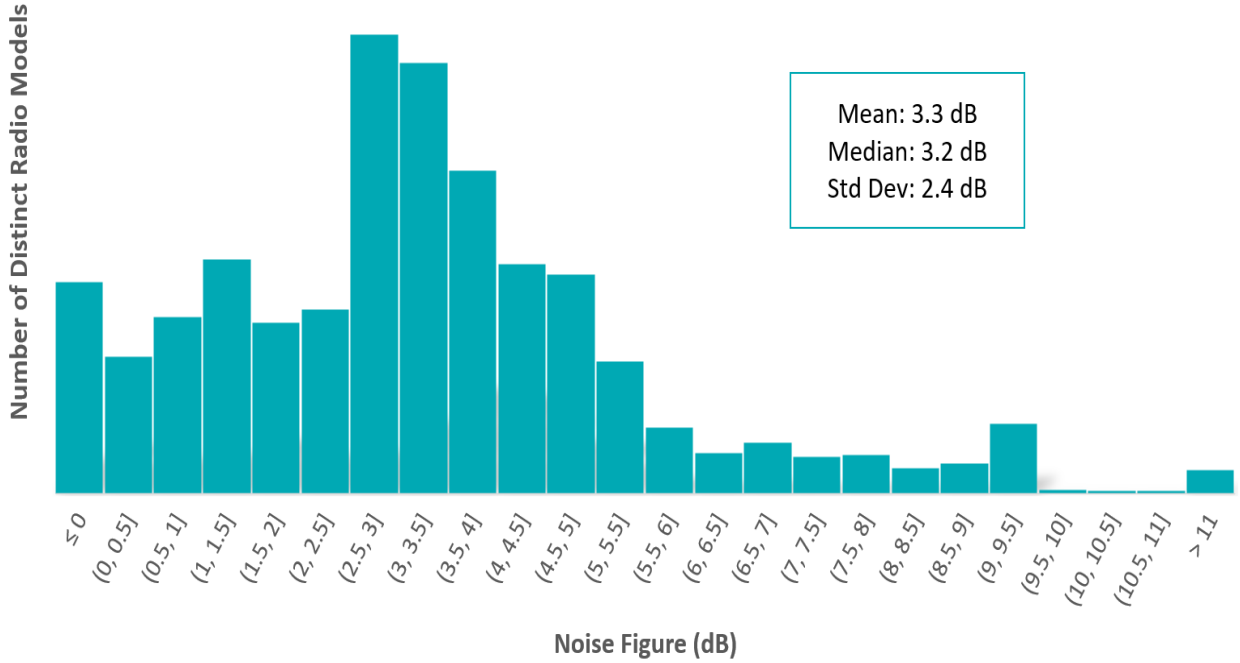

Figure 9: Noise Figure by distinct radio model using Comsearch radio data only

Using either the Threshold-to-Interference method or a default Noise Figure may be appropriate for calculating the noise floor. These histograms represent the statistical distribution of Noise Figure and can be used to inform discussion.

Appendix A
Using ULS Data

Data Access

Complete files are posted weekly at https://www.fcc.gov/uls/transactions/daily-weekly. The file is in the "Weekly Databases" section under the heading "Microwave - 47 CFR Parts 74 and 101, and 3650 - 3700 MHz". Licensed links are normally posted on Monday morning and are in the file l_micro.zip (l = licensed, micro = microwave). Applications are in a_micro.zip (a = applications), and are normally posted Sunday morning.

Differential files are posted in-between weekly files and are available in the "Daily Databases" section under the heading "Microwave - 47 CFR Parts 74 and 101, and 3650 - 3700 MHz". Newly-licensed links for the prior day's data are in the l_mw_<day>.zip file (e.g., "l_mw_mon.zip" for Monday's file). New applications from the previous day are in a_mw_<day>.zip.

Documentation

Documentation about the ULS database is available at the following links:

- FCC Documentation
  - https://www.fcc.gov/wireless/data/public-access-files-database-downloads
- Introduction to the data
  - https://www.fcc.gov/sites/default/files/pubacc_intro_11122014.pdf
- Sybase SQL to create tables:
  - https://www.fcc.gov/sites/default/files/public_access_database_definitions_sql_v2.txt
- Table Definitions in PDF Format:
  - https://www.fcc.gov/sites/default/files/public_access_database_definitions_v3.pdf
- Code definitions (provides a lookup for various field codes to plain English):
  - https://www.fcc.gov/sites/default/files/pubacc_uls_code_def_02162017.txt

ULS Tables

Two sets of data are necessary: microwave applications, and microwave licenses (see above). The specific tables that are needed are highlighted in the figure below. "R" and "O" mark whether a specific table is required or optional for the microwave database.

Tables	Table Contents	Microwave		Tables	Table Contents	Microwave	
Hierarchy		App	Lic	Hierarchy		App	Lic
HD	Main Form 601 data that carries over to license	R	R	LO	Location data	O	R
AD	Main Form 601 data that does not carry over to license	R		L2	Additional Location data	O	O
A2	Additional Application data that does not carry over to the license	R		LS	Location Level Canned Special Conditions	O	O
RE	Application return or dismissal reasons	O		LF	Location Level Free Form Special Conditions	O	O
EN	Names and addresses	R	R	AN	Antenna data	O	R
CO	FCC Comments	O	O	RC	Receiver data	O	O
HS	Application and License history	R	R	FR	Frequency data	O	R
IR	IRAC status	O	O	F2	Additional frequency data	O	O
CS	COSER status	O	O	TP	Transmission Method or Protocol	R	R
MW	Microwave administrative data	O	R	FS	Frequency Level Canned Special Conditions	O	O
BC	Broadcast Call Signs	O	O	FF	Frequency Level Free Form Special Conditions	O	O
FC	Frequency Coordination	O		BF	Frequency build out data		R
SC	License Level Canned Special Conditions	O	O	EM	Emission data	O	R
SF	License Level Free Form Special Conditions	O	O	PA	Paths	O	R
CP	Control point data	O	O	SG	Segments	O	R
CF	Multiple call signs or file numbers affected by this application	O		AT	Attachment information	O	

The HD table is the top-level data table. The “Unique System Identifier” (USI) field in each table is used to join tables together for the same filing or call sign. Note however that the USI is different between application and license tables for the same call sign.

Data can be joined whenever the column name is the same in both tables. The primary column for joining license data is the call sign. The primary column for joining application data is ULS file number. In addition to the call sign or ULS file number, each application and license has been assigned a unique, 9-digit system identifier. This system identifier is useful in cases where a call sign has been reassigned, insofar as it allows you to differentiate between the active call sign

and the call sign that has expired or been cancelled or terminated. (This situation occurs commonly with Amateur vanity licenses.)

Site-based services (such as fixed microwave links) can be joined by the following combination of columns:

- call_sign or unique_system_identifier
- call_sign or unique_system_identifier and location_number
- call_sign or unique_system_identifier, location_number and antenna_number
- call_sign or unique_system_identifier, location_number, antenna_number and frequency_number
- call_sign or unique_system_identifier, path number, location_number and antenna_number
- call_sign or unique_system_identifier, path_number and segment_number

Header Data

Header table (HD.dat) contains key license information. The License Status indicates whether the license is active, but the Cancellation date, when populated indicates whether the record should not be protected. The required fields from the header table are highlighted in the figure below.

Application / License Header

Position	Data Element	Definition
1	Record Type **[HD]**	char(2)
2	Unique System Identifier	numeric(9,0)
3	ULS File Number	char(14)
4	EBF Number	varchar(30)
5	Call Sign	char(10)
6	License Status	char(1)
7	Radio Service Code	char(2)
8	Grant Date	mm/dd/yyyy
9	Expired Date	mm/dd/yyyy
10	Cancellation Date	mm/dd/yyyy
11	Eligibility Rule Num	char(10)
12	Reserved	char(1)
13	Alien	char(1)
14	Alien Government	char(1)
15	Alien Corporation	char(1)
16	Alien Officer	char(1)
17	Alien Control	char(1)
18	Revoked	char(1)
19	Convicted	char(1)
20	Adjudged	char(1)
21	Reserved	char(1)
22	Common Carrier	char(1)
23	Non Common Carrier	char(1)
24	Private Comm	char(1)
25	Fixed	char(1)
26	Mobile	char(1)

(additional fields not shown).

Path Data

The path table (PA.dat) contains key information that links locations (transmit and receive, and also antennas). The necessary fields are highlighted below.

Microwave Path

Position	Data Element	Definition
1	Record Type **[PA]**	char(2)
2	Unique System Identifier	numeric(9,0)
3	ULS File Number	char(14)
4	EBF Number	varchar(30)
5	Call Sign	char(10)
6	Action Performed	char(1)
7	Path Number / Link Number	integer
8	Transmit Location Number	integer
9	Transmit Antenna Number	integer
10	Receiver Location Number	integer
11	Receiver Antenna Number	integer
12	MAS/DEMS SubType of Operation	char(2)
13	Path Type Code	char(20)
14	Passive Receiver Indicator	char(1)
15	Country Code	char(3)
16	Interference to GSO?	char(1)
17	Receiver Call Sign	varchar(10)
18	Angular Separation	numeric(3,2)
19	Cert No Alternative	char(1)
20	Cert No Interference	char(1)
21	Status Code	char(1)
22	Status Date	mm/dd/yyyy

Segment Data

The segment table (SG.dat) contains key information that orders segments, and is required for passive repeater sequencing. Segments are individual point-to-point links that make up a potentially longer (multi-segment) microwave path.

Microwave Segments

Position	Data Element	Definition
1	Record Type [SG]	char(2)
2	Unique System Identifier	numeric(9,0)
3	ULS File Number	char(14)
4	EBF Number	varchar(30)
5	Call Sign	char(10)
6	Action Performed	char(1)
7	Path Number	integer
8	Transmit Location Number	integer
9	Transmit Antenna Number	integer
10	Receiver Location Number	integer
11	Receiver Antenna Number	integer
12	Segment Number	integer
13	Segment Length	numeric(12,6)
14	Status Code	char(1)
15	Status Date	mm/dd/yyyy

Location Data

The location table (LO.dat) contains technical site information, where Location Number 1 is the Transmit site, all other numbers are the receive sites.

Location

Position	Data Element	Definition
1	Record Type [LO]	char(2)
2	Unique System Identifier	numeric(9,0)
3	ULS File Number	char(14)
4	EBF Number	varchar(30)
5	Call Sign	char(10)
6	Location Action Performed	char(1)
7	Location Type Code	char(1)
8	Location Class Code	char(1)
9	Location Number	integer
10	Site Status	char(1)
11	Corresponding Fixed Location	integer
12	Location Address	varchar(80)
13	Location City	char(20)
14	Location County/Borough/Parish	varchar(60)
15	Location State	char(2)
16	Radius of Operation	numeric(5,1)
17	Area of Operation Code	char(1)
18	Clearance Indicator	char(1)
19	Ground Elevation	numeric(7,1)
20	Latitude Degrees	integer
21	Latitude Minutes	integer
22	Latitude Seconds	numeric(3,1)
23	Latitude Direction	char(1)
24	Longitude Degrees	integer
25	Longitude Minutes	integer
26	Longitude Seconds	numeric(3,1)

27	Longitude Direction	char(1)
28	Max Latitude Degrees	integer
29	Max Latitude Minutes	integer
30	Max Latitude Seconds	numeric(3,1)
31	Max Latitude Direction	char(1)
32	Max Longitude Degrees	integer
33	Max Longitude Minutes	integer
34	Max Longitude Seconds	numeric(3,1)
35	Max Longitude Direction	char(1)
36	Nepa	char(1)
37	Quiet Zone Notification Date	mm/dd/yyyy
38	Tower Registration Number	char(10)
39	Height of Support Structure	numeric(7,1)
40	Overall Height of Structure	numeric(7,1)
41	Structure Type	char(7)
42	Airport ID	char(4)
43	Location Name	char(20)
44	Units Hand Held	integer

(not all fields shown).

Antenna Data

The antenna table (AN.dat) contains antenna details, including primary and diversity antenna information and polarization. For passive repeaters, additional details are also included. Note that Line Loss appears in this table, but this information is not collected for the fixed microwave service.

Antenna

Position	Data Element	Definition
1	Record Type **[AN]**	char(2)
2	Unique System Identifier	numeric(9,0)
3	ULS File Number	char(14)
4	EBF Number	varchar(30)
5	Call Sign	char(10)
6	Antenna Action Performed	char(1)
7	Antenna Number	integer
8	Location Number	integer
9	Receive Zone Code	char(6)
10	Antenna Type Code	char(1)
11	Height to Tip	numeric(5,1)
12	Height to Center RAAT	numeric(5,1)
13	Antenna Make	varchar(25)
14	Antenna Model	varchar(25)
15	Tilt	numeric(3,1)
16	Polarization Code	char(5)
17	Beamwidth	numeric(4,1)
18	Gain	numeric(4,1)
19	Azimuth	numeric(4,1)

20	Height Above Avg Terrain	numeric(5,1)
21	Diversity Height	numeric(5,1)
22	Diversity Gain	numeric(4,1)
23	Diversity Beam	numeric(4,1)
24	Reflector Height	numeric(5,1)
25	Reflector Width	numeric(4,1)
26	Reflector Separation	numeric(5,1)
27	Passive Repeater Number	integer
28	Back-to-Back Tx Dish Gain	numeric(4,1)
29	Back-to-Back Rx Dish Gain	numeric(4,1)
30	Location Name	varchar(20)
31	Passive Repeater Sequence ID	integer
32	Alternative CGSA Method	char(1)
33	Path Number	integer
34	Line loss	numeric(3,1)
35	Status Code	char(1)
36	Status Date	mm/dd/yyyy
37	PSD/Non-PSD Methodology	varchar(10)
38	Maximum ERP	numeric(15,3)

Frequency Data

The frequency table (FR.dat) contains the frequency and radio information for each antenna.

Frequency

Position	Data Element	Definition
1	Record Type **[FR]**	char(2)
2	Unique System Identifier	numeric(9,0)
3	ULS File Number	char(14)
4	EBF Number	varchar(30)
5	Call Sign	char(10)
6	Frequency Action Performed	char(1)
7	Location Number	integer
8	Antenna Number	integer
9	Class Station Code	char(4)
10	Op Altitude Code	char(2)
11	Frequency Assigned	numeric(16,8)
12	Frequency Upper Band	numeric(16,8)
13	Frequency Carrier	numeric(16,8)
14	Time Begin Operations	integer
15	Time End Operations	integer

16	Power Output	numeric(15,3)
17	Power ERP	numeric(15,3)
18	Tolerance	numeric(6,5)
19	Frequency Indicator	char(1)
20	Status	char(1)
21	EIRP	numeric(7,1)
22	Transmitter Make	varchar(25)
23	Transmitter Model	varchar(25)
24	Auto Transmitter Power Control	char(1)
25	Number of Units	integer
26	Number of Paging Receivers	integer
27	Frequency Number	integer
28	Status Code	char(1)
29	Status Date	mm/dd/yyyy
30	Date First Used	mm/dd/yyyy

Emission Data

The emission table (EM.dat) contains the emission bandwidth information for each frequency.

Emission

Position	Data Element	Definition
1	Record Type **[EM]**	char(2)
2	Unique System Identifier	numeric(9,0)
3	ULS File Number	char(14)
4	EBF Number	varchar(30)
5	Call Sign	char(10)
6	Location Number	integer
7	Antenna Number	integer
8	Frequency Assigned/Channel Center	numeric(16,8)
9	Emission Action Performed	char(1)
10	Emission Code	char(10)
11	Digital Mod Rate	numeric(8,1)
12	Digital Mod Type	char(255)
13	Frequency Number	integer
14	Status Code	char(1)
15	Status Date	mm/dd/yyyy
16	Emission Sequence Id	integer

ULS Sample

The following sample shows a set of data that would appear for a single license in each .dat file for the applicable table, HD, PA, LO, AN, FR, and EM. The data have been joined by the Unique System Identifier (the second field in each record).

```
HD|4082800|0008669102||WRCF240|A|CF|09/14/2018|09/14/2028||||N|N|N|N|N|N|N|N|
|Y||Y|Y|N|N|N|N|N|Sean|R|Middleton||Manager of
Engineering|||||||10/04/2019|06/28/2020||||N|||

PA|4082800|||WRCF240||2|1|2|2|2||Fixed Point-to-Point|N||N||||||

SG|4082800|||WRCF240||2|1|2|2|2|1|17.385819||

LO|4082800|||WRCF240||F|T|1|||Rearl Hill
Top|Pearl|PIKE|IL||||196.0|39|27|0.0|N|90|37|26.0|W||||||||||||51.8|53.3|LTOW
ER||PEARL HILLTOP|||||||

LO|4082800|||WRCF240||F|R|2|||||||||||220.3|39|17|46.0|N|90|39|40.5|W|||||||||
|||||||KAMPSVILLE TOWER|||||||

AN|4082800|||WRCF240||2|1||T||47.2|RADIO WAVES INC.|HPD3-
11|0.1|V|2.1|38.5|190.7||||||||||PEARL HILLTOP|||2|||||

AN|4082800|||WRCF240||2|2||R||54.9|RADIO WAVES INC.|HPD3-
11|||2.1|38.5||||||||||||KAMPSVILLE TOWER|||2|||||

FR|4082800|||WRCF240||1|2|FXO||10755.00000000|||||||0.00040|||59.5|CERAGON
NETWORKS|FibeAir-IP-20C|N|||1|||07/30/2019


FR|4082800|||WRCF240||1|2|FXO||10755.00000000|||||||0.00040|||61.5|CERAGON
NETWORKS|FibeAir-IP-20C|N|||2|||07/30/2019

FR|4082800|||WRCF240||1|2|FXO||10755.00000000|||||||0.00040|||61.5|CERAGON
NETWORKS|FibeAir-IP-20C|N|||3|||07/30/2019

EM|4082800|||WRCF240|1|2|10755.00000000||60M0D7W|530000.0|2048QA|1|||1

EM|4082800|||WRCF240|1|2|10755.00000000||60M0D7W|489000.0|1024QA|2|||1

EM|4082800|||WRCF240|1|2|10755.00000000||60M0D7W|460000.0|1024QA|3|||1
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