Exhibit D: Interference Study
Swarm Technologies Inc.

Swarm Technologies, Inc

137-138 and 148-150.05 MHz EMC Study

Provided by Skjei Telecom, Inc

December 2, 2018

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1.0 Introduction

Swarm Technologies is seeking an FCC License in support of their nanosat system. The frequency bands of interest are 137-138 MHz (downlink) and 148-150.05 MHz (uplink). Swarm is requesting operation of a 20.8 kHz carrier operating on channels in the 137.025 – 138.0 MHz band in the space-to-Earth direction and in the 148.25-149.95 MHz band in the Earth-to-space direction.

Swarm has performed an interference analysis to show that they do not interfere with in-band and adjacent band licensees. The areas of operational include CONUS and OCONUS. This report provides the technical parameters regarding the operation of the links and examines the potential for interference into terrestrial based systems from the space-based transmitters.

2.0 The SWARM System

The Swarm Constellation will constitute 150 operational satellites in low earth orbit using equatorial (0°) to polar sun-synchronous (98°) inclination angles. The system will use standard VHF frequencies which are currently assigned on a primary basis to Mobile Satellite Services. Specifically, the spectrum of interest is within the 137-138 MHz band for the downlink (space-to-Earth) and 148-150.05 MHz band for the uplink (Earth-to-space). Detailed technical parameters and channel plans are included below.

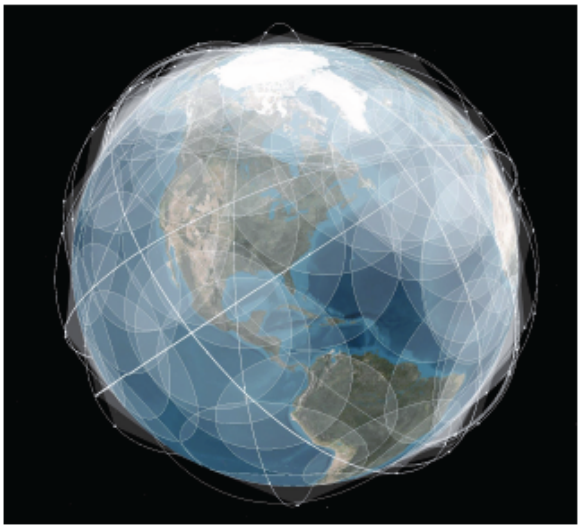

Figure 1 - Swarm Constellation

3.0 Swarm Technical Parameters

Satellites

- **Number of satellites:** 150 operational satellites (will be replenished as needed)
- **Size:** 1/4U (11 cm x 11 cm x 2.8 cm)
- **Lifetime:** 2.5 years (min) to 12.2 years (max), typically 3 to 5 years

Orbital Parameters

- **Altitude:** 400 to 550 km
- **Inclination:** equatorial (0°) to polar sun-synchronous (98°)
- **Orbital period:** 92 to 96 minutes

Frequencies and Emissions

- **Frequencies:** within 137-138 and 148-149.95 MHz bands and not currently assigned to Orbcomm on a primary basis
    - **Uplink:** 500.0 kHz total
        - 148.2500-148.5850 MHz
        - 148.6350-148.7500 MHz
        - 149.9000-149.9500 MHz
    - **Downlink:** 512.5 kHz total
        - 137.0250-137.1750 MHz
        - 137.3275-137.3750 MHz
        - 137.4725-137.5350 MHz
        - 137.5850-137.6500 MHz
        - 137.8125-138.0000 MHz
- **Bandwidth:** 20.8 kHz (standard emission designator), adjustable from 7 to 125 kHz
- **Emission Designator:** F1D
- **Power level:** 1.5W
- **Space station antenna gain:** 0 dBi
- **Maximum power flux density:** -125.9 dBW/m^2/4kHz at Earth's surface for minimum operational altitude of 300 km (below ITU threshold
- requiring coordination with terrestrial services)
- **Maximum out-of-band emissions into Radio Astronomy Service (RAS) bands:** -262.0
- dBW/m^2/Hz for minimum operational altitude of 300 km (meets protection criteria for 150.05-153 MHz RAS band)

Table 1 - Swarm System Technical Parameters

Downlink Channel Parameters	- All channels are 30 kHz wide and spaced 30 kHz apart			
	- Each 30 kHz channel consists of a necessary BW of 20.8 kHz plus an additional 9.2 kHz to account for Doppler shift and frequency tolerance			
	- Channels are centered in the frequency ranges.			
Frequency ranges	137.025-137.175 MHz			
	137.3275-137.375 MHz			
	137.4725-137.535 MHz			
	137.585-137.65 MHz			
	137.8125-138 MHz			
Center frequency (MHz)	**Lower frequency (MHz)**	**Upper frequency (MHz)**	**Bandwidth (kHz)**	**Channel**
	137.0250	137.0400	15.0	Skirt
137.0550	137.0400	137.0700	30.0	T001
137.0850	137.0700	137.1000	30.0	T002
137.1150	137.1000	137.1300	30.0	T003
137.1450	137.1300	137.1600	30.0	T004
	137.1600	137.1750	15.0	Skirt
	137.3275	137.3363	8.8	Skirt
137.3513	137.3363	137.3663	30.0	T005
	137.3663	137.3750	8.8	Skirt
	137.4725	137.4888	16.3	Skirt
137.5038	137.4888	137.5188	30.0	T006
	137.5188	137.5350	16.3	Skirt
	137.5850	137.6025	17.5	Skirt
137.6175	137.6025	137.6325	30.0	T007
	137.6325	137.6500	17.5	Skirt
	137.8125	137.8313	18.8	Skirt
137.8463	137.8313	137.8613	30.0	T008
137.8763	137.8613	137.8913	30.0	T009
137.9063	137.8913	137.9213	30.0	T010
137.9363	137.9213	137.9513	30.0	T011
137.9663	137.9513	137.9813	30.0	T012
	137.9813	138.0000	18.8	Skirt

Table 2 - Downlink Channel Assignments

Downlink Channel Parameters	- All channels are 30 kHz wide and spaced 30 kHz apart			
	- Each 30 kHz channel consists of a necessary BW of 20.8 kHz plus an additional 9.2 kHz to account for Doppler shift and frequency tolerance			
	- Channels are centered in the frequency ranges.			
Frequency ranges	148.250-148.585 MHz			
	148.635-148.750 MHz			
	149.900-149.950 MHz			
Center frequency (MHz)	**Lower frequency (MHz)**	**Upper frequency (MHz)**	**Bandwidth (kHz)**	**Channel**
	148.2500	148.2675	17.5	Skirt
148.2825	148.2675	148.2975	30.0	R001
148.3125	148.2975	148.3275	30.0	R002
148.3425	148.3275	148.3575	30.0	R003
148.3725	148.3575	148.3875	30.0	R004
148.4025	148.3875	148.4175	30.0	R005
148.4325	148.4175	148.4475	30.0	R006
148.4625	148.4475	148.4775	30.0	R007
148.4925	148.4775	148.5075	30.0	R008
148.5225	148.5075	148.5375	30.0	R009
148.5525	148.5375	148.5675	30.0	R010
	148.5675	148.5850	17.5	Skirt
	148.6350	148.6475	12.5	Skirt
148.6625	148.6475	148.6775	30.0	R011
148.6925	148.6775	148.7075	30.0	R012
148.7225	148.7075	148.7375	30.0	R013
	148.7375	148.7500	12.5	Skirt
	149.9000	149.9100	10.0	Skirt
149.9250	149.9100	149.9400	30.0	R014
	149.9400	149.9500	10.0	Skirt

Table 3 – Uplink Channel Assignments

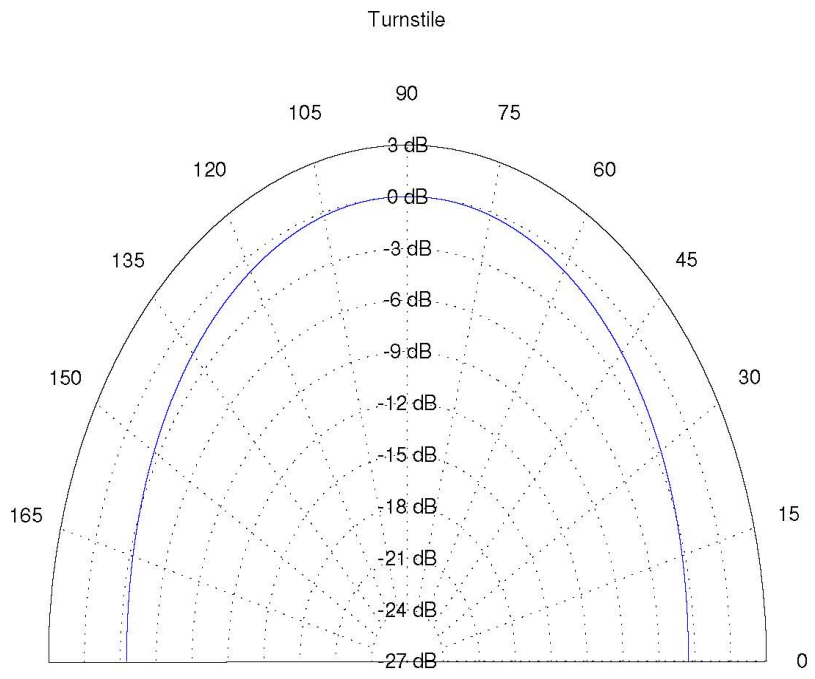

Figure 2 – Space Station Transmit and Receive Turnstile Antenna

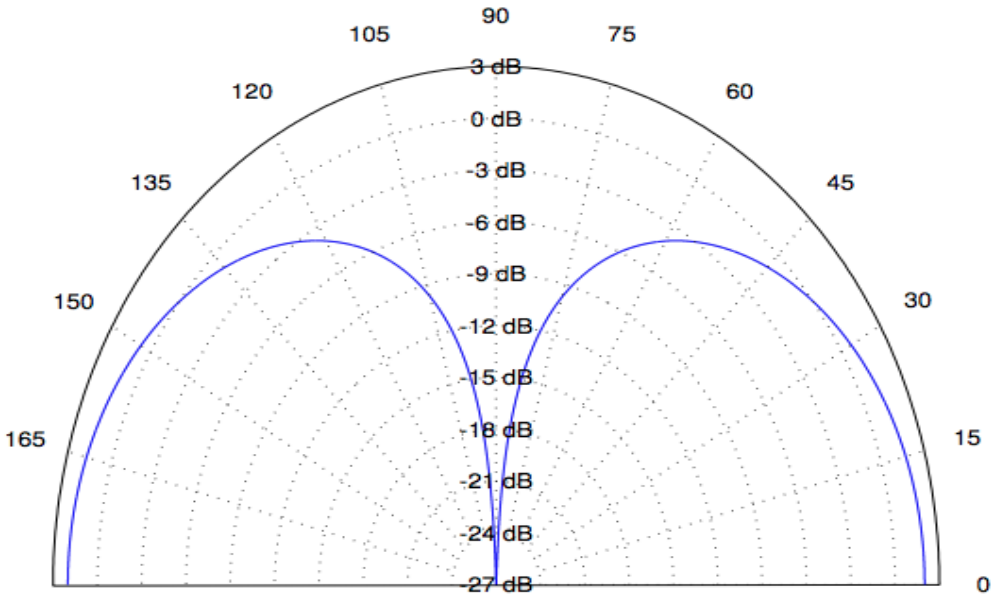

Figure 3 – Ground Transmit and Receive Half-Wave Monopole Antenna

4.0 Database Search for In-band and Adjacent Band Services

IBFS Results – As can be seen, in Table A.1 in Appendix II, the only licenses which have been granted include Orbcomm, a company called Terra Bella Technologies and one other, Scientific Atlanta, Inc. All other satellite licenses in the band were either dismissed or surrendered. A detailed search of the Terra Bella license, shows that the actual frequencies of operation for this satellite system is 8025-8400 MHz Space-to-Earth and 2025-2110 Earth-to-Space. The notation in the database search results that the system operates between 137-138 MHz or 148 to 150 MHz is in error. A detailed review of all actions, including licenses, STAs, and modification show that no grant of operation between 137-138 MHz or 148 to 150 MHz has been given (or requested for that matter). A detailed search of the Scientific Atlanta, Inc. revealed that the actual frequencies are 148 to 149.9 MHz for two fixed earth stations, with site locations in Atlanta, GA and Lawrenceville, GA. However, when compared to other databases, it was found that the license type for the Lawrenceville, GA was granted a "Special Temporary Authority", and since the application of this license was released and adopted 6/11/1997, it can be assumed that this grant has expired, though the filing lacks an expiration date on the FCC database. For both licenses, there are no additional standing filing documents, which leads to the assumption that both licenses have expired. Licenses that have yet to expire are linked to a variety of documents that are not present on the Scientific Atlanta, Inc. licenses. This company became part of Cisco in 2005, which has the majority of their fixed earth stations at frequencies between 10950 and 14500. So, it appears that the only satellite operator in the band is Orbcomm. More coordination with Orbcomm will be required.

ULS Database - The ULS database revealed only a few records within the uplink and downlink passbands. There were many mobile Aviation licenses held by Aviation Spectrum Resources, Inc. in the band below 137 MHz. Above 138 MHz there were a few fixed link licenses. Within the 137-138 MHz there were no current licenses shown in the ULS. Directly below 148 MHz there were no licenses in the ULS. There were no records between 148.0-149.9 MHz. Directly above 149.9 MHz there were a few fixed link licenses.

OET ELS Database - The FCC's Office of Engineering Technology Experimental Licensing database was culled to determine if any existing licenses propose to use bands which overlap the Swarm uplink and downlink spectrum. These will mainly be examined to determine if there is any useful interference assessment or coordination material which may be applicable to the Swarm analysis.

5.0 Interference Criteria and Analysis

The maximum permissible level of interference into terrestrial services is provided in the ITU-R Radio Regulations Volume 2 Appendix 5 Annex 1, excepted below:

1 Coordination thresholds for sharing between MSS (space-to-Earth) and terrestrial services in the same frequency bands and between non-GSO MSS feeder links (space-to-Earth) and terrestrial services in the same frequency bands and between RDSS (space-to-Earth) and terrestrial services in the same frequency bands *(WRC-12)*

*1.1 Below 1 GHz**

1.1.1 In the bands 137-138 MHz and 400.15-401 MHz, coordination of a space station of the MSS (space-to-Earth) with respect to ***terrestrial services*** *(except aeronautical mobile (OR) service networks operated by the administrations listed in Nos. 5.204 and 5.206 as of 1 November 1996) is -125 dB(W/(m2 · 4 kHz)) at the earth surface.*

1.1.2 In the band 137-138 MHz, coordination of a space station of the MSS (space-to-Earth) with respect to the ***aeronautical mobile (OR) service*** *is required only if the pfd produced by this space station at the Earth's surface exceeds:*

*- -125 dB(W/(m2 · 4 kHz)) for networks for which complete Appendix 3** coordination information has been received by the Bureau prior to 1 November 1996;*

*- -140 dB(W/(m2 · 4 kHz)) for networks for which complete Appendix 4/S4/3** coordination information has been received by the Bureau after 1 November 1996 for the administrations referred to in § 1.1.1 above.*

** These provisions apply only to the MSS.*

<u>Interference into In-Band and Adjacent Band Services</u>

The interference criteria for the protection of in-band terrestrial services is -125 dBW/m²/4kHz. Using this value and free space loss only, it can be shown that no in-band non-US based system, of which a comprehensive database search revealed that none exist, will be affected. No adjacent band system will be affected. Table 4 below summarizes the PFD levels from the spacecraft and compares levels for in-band and out-of-band licensees. No interference potential exists.

Table 4 - Swarm Interference Calculations for Downlink at 137 MHz		
ITU-R Limit for interference into aeronautical mobile (OR) services in the band 137-138 MHz[1]:	-140.0	dBW/m^2/4kHz [2]
ITU-R Limit for interference into terrestrial services in the band 137-138 MHz:	-125.0	dBW/m^2/4kHz [2]
Frequency of operation	137.0	MHz
Wavelength	2.1883	meters
Bandwidth	20.8	kHz
RF Power	1.5	W
EIRP	1.76	dBW/20.8 kHz
	-5.4	dBW/4kHz
Ao	-4.19	dB-meters
Spacecraft Altitude	500.0	km
Max Interfering Power Flux Density (worst case elevation angle)	-130.4	dBW/m^2/4kHz *
Margin over objective Terrestrial Services	5.4	dB, positive Clears
Worst Case Frequency Separation between Downlink Channel and Adjacent AM (OR) Services (see Table 2)	18.8	kHz
Minimum Attenuation due to Downlink Channel Filter at Separation (see Table 6)	38	dB
Margin over objective aeronautical mobile (OR) services	28.4	dB, positive clears

Notes:

1. There are no aeronautical mobile services allocated in the 137-138 MHz band, there is an international allocation for aeronautical mobile in the adjacent band above 138 MHz

2. See ITU-R Radio Regulations Vol II Appendix 5, Annex 1 article 1.2.2

Table 5 below provides a detailed summary of the PFD calculations at 137 MHz. Figure 4 and Table 6 below provide details on the spacecraft downlink transmitter emission response and mask.

		Value	Unit		
Power		1.5	W		
Altitude of sat		500	km		
Sat antenna gain		0	dBi		
Channel bandwidth		20.8	kHz		
Bandwidth of interest		4	kHz		
Max EIRP		1.760912591	dBW		
Min altitude		300	km		
Max altitude		550	km		
Ground max gain		2	dBi		
Ground min gain		-27	dBi		
Max EIRP density		0.0000721	W/Hz		
Max EIRP density		-41.42	dBW/Hz		

Elevation angle	**PFD Limit**	**Sat antenna gain**	**PFD (W/m2)**	**PFD (W/m2/Hz)**	**PFD (dBW/m2/Hz)**	**PFD for 500 km orbit**
0	-125	-3.528612531	2.12E-13	1.02E-17	-169.919832	-133.8992321
5	-125	-3.498029007	2.13E-13	1.03E-17	-169.8892485	-133.8686486
10	-125	-3.408378348	2.18E-13	1.05E-17	-169.7995978	-133.7789979
15	-125	-3.263766876	2.25E-13	1.08E-17	-169.6549864	-133.6343864
20	-125	-3.070362445	2.35E-13	1.13E-17	-169.4615819	-133.440982
25	-125	-2.835868622	2.49E-13	1.19E-17	-169.2270881	-133.2064882
30	-125	-2.569047641	2.64E-13	1.27E-17	-168.9602671	-132.9396672
35	-125	-2.279292131	2.82E-13	1.36E-17	-168.6705116	-132.6499117
40	-125	-1.976245607	3.03E-13	1.46E-17	-168.3674651	-132.3468652
45	-125	-1.669471742	3.25E-13	1.56E-17	-168.0606912	-132.0400913
50	-125	-1.368172404	3.48E-13	1.68E-17	-167.7593919	-131.738792
55	-125	-1.080954462	3.72E-13	1.79E-17	-167.4721739	-131.451574
60	-125	-0.81564537	3.96E-13	1.90E-17	-167.2068649	-131.1862649
65	-125	-0.579157516	4.18E-13	2.01E-17	-166.970377	-130.9497771
70	-125	-0.377401346	4.38E-13	2.10E-17	-166.7686208	-130.7480209
75	-125	-0.215247255	4.54E-13	2.18E-17	-166.6064667	-130.5858668
80	-125	-0.096536254	4.67E-13	2.25E-17	-166.4877557	-130.4671558
85	-125	-0.024139404	4.75E-13	2.28E-17	-166.4153589	-130.394759
90	-125	0.00E+00	4.77E-13	2.30E-17	-166.3912195	-130.3706196

Table 5 – PFD Level Calculations for Swarm Downlink at 137-138 MHz

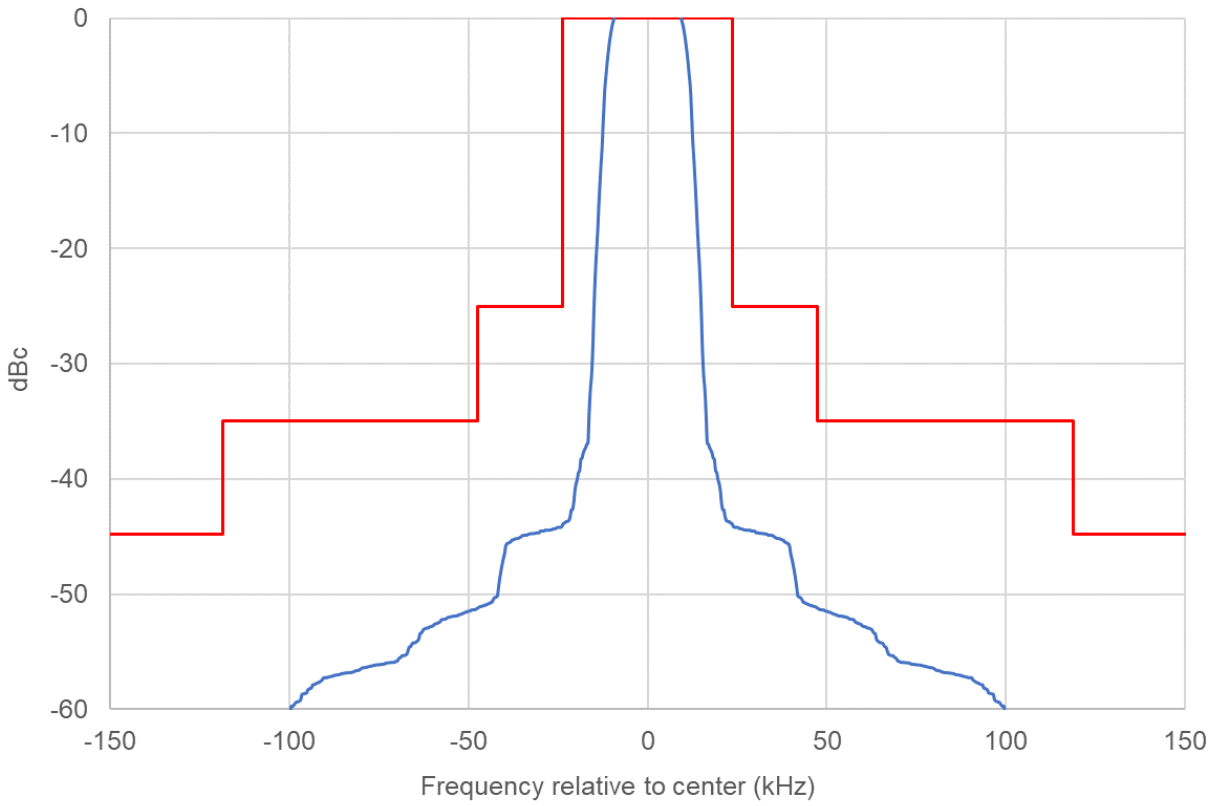

Figure 4 – Transmit Channel Filter Response, table below details performance between +/- 20 kHz

Frequency from center (kHz)	Emission (dBc)		Frequency from center (kHz)	Emission (dBc)
-19.747	-40.02		-0.766	0.36
-19.414	-39.42		-0.433	0.38
-19.081	-39.26		-0.1	0.3
-18.748	-38.27		0.233	0.38
-18.415	-38.18		0.566	0.36
-18.082	-37.73		0.899	0.35
-17.749	-37.46		1.232	0.35
-17.416	-37.28		1.565	0.34
-17.083	-36.96		1.898	0.34
-16.75	-36.88		2.231	0.34
-16.417	-34.27		2.564	0.32
-16.084	-32.21		2.897	0.32
-15.751	-30.96		3.23	0.31
-15.418	-28.75		3.563	0.31
-15.085	-25.31		3.896	0.31
-14.752	-22.55		4.229	0.3
-14.419	-20.5		4.562	0.3
-14.086	-18.64		4.895	0.3
-13.753	-16.42		5.228	0.3
-13.42	-14.41		5.561	0.3

-13.087	-12.54		5.894	0.28
-12.754	-10.88		6.227	0.27
-12.421	-8.43		6.56	0.25
-12.088	-6.27		6.893	0.25
-11.755	-5.05		7.226	0.24
-11.422	-3.93		7.559	0.24
-11.089	-2.94		7.892	0.23
-10.756	-2.09		8.225	0.22
-10.423	-1.36		8.558	0.21
-10.09	-0.77		8.891	0.21
-9.757	-0.34		9.224	0.05
-9.424	0.05		9.557	-0.34
-9.091	0.21		9.89	-0.77
-8.758	0.21		10.223	-1.36
-8.425	0.22		10.556	-2.09
-8.092	0.23		10.889	-2.94
-7.759	0.24		11.222	-3.93
-7.426	0.24		11.555	-5.05
-7.093	0.25		11.888	-6.27
-6.76	0.25		12.221	-8.43
-6.427	0.27		12.554	-10.88
-6.094	0.28		12.887	-12.54
-5.761	0.3		13.22	-14.41
-5.428	0.3		13.553	-16.42
-5.095	0.3		13.886	-18.64
-4.762	0.3		14.219	-20.5
-4.429	0.3		14.552	-22.55
-4.096	0.31		14.885	-25.31
-3.763	0.31		15.218	-28.75
-3.43	0.31		15.551	-30.96
-3.097	0.32		15.884	-32.21
-2.764	0.32		16.217	-34.27
-2.431	0.34		16.55	-36.88
-2.098	0.34		16.883	-36.96
-1.765	0.34		17.216	-37.28
-1.432	0.35		17.549	-37.46
-1.099	0.35		17.882	-37.73

Table 6 – Spacecraft Downlink Transmitter Emission Response with Mask

Appendices 1 and 2 below contain the FCC Frequency Allocation Tables and Footnotes and the Result of the searches of the FCC Databases, IBFS, OET, and ULS.

Appendix 1 - FCC Frequency Allocation Tables and Footnotes

Table of Allocations at 137 MHz and 148 MHz

<table>
<tr><th colspan="2">United States Table</th><th rowspan="2">FCC Rule Part(s)</th></tr>
<tr><th>Federal Table</th><th>Non-Federal Table</th></tr>
<tr><td>136-137

US244</td><td>136-137
AERONAUTICAL MOBILE ®
US244</td><td>Aviation (87)</td></tr>
<tr><td colspan="2">137-137 025 137-137 025
SPACE OPERATION (space-to-Earth))
METEOROLOGICAL-SATELLITE (space-to-Earth)
MOBILE-SATELLITE (space-to-Earth) US319 US320
SPACE RESEARCH (space-to-Earth)
5.208</td><td rowspan="4">Satellite Communications (25)</td></tr>
<tr><td colspan="2">137.025-137.175
SPACE OPERATION (space-to-Earth)
METEOROLOGICAL-SATELLITE (space-to-Earth)
SPACE RESEARCH (space-to-Earth)
Mobile-satellite (space-to-Earth) US319 US320
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SPACE OPERATION (space-to-Earth)
METEOROLOGICAL-SATELLITE (space-to-Earth)
MOBILE-SATELLITE (space-to-Earth) US319 US320
SPACE RESEARCH (space-to-Earth)
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<tr><td colspan="2">137.025-137.175
SPACE OPERATION (space-to-Earth)
METEOROLOGICAL-SATELLITE (space-to-Earth)
SPACE RESEARCH (space-to-Earth)
Mobile-satellite (space-to-Earth) US319 US320
5.208</td></tr>
<tr><td>138-144
FIXED
MOBILE

G30</td><td>138-144</td><td></td></tr>
<tr><td rowspan="2">144-148</td><td>144-146
AMATEUR
AMATEUR-SATELLITE</td><td rowspan="2">Amateur Radio (97)</td></tr>
<tr><td>146-148
AMATEUR</td></tr>
<tr><td>148-149.9
FIXED
MOBILE
MOBILE-SATELLITE
(Earth-to-space) US319
US320 US323 US325

5.218 5.219 G30</td><td>148-149.9
MOBILE-SATELLITE
(Earth-to-space) US320
US323 US325

5.218 5.219 G30</td><td rowspan="2">Satellite communications (25)</td></tr>
<tr><td colspan="2">149.9-150.05
MOBILE-SATELLITE (Earth-to-space) US319 US320
RADIONAVIGATION-SATELLITE

5.223</td></tr>
</table>

Table of Allocation Footnotes

5.208 The use of the band 137-138 MHz by the mobile-satellite service is subject to coordination under No. 9.11A.

5.218 *Additional allocation:* the band 148-149.9 MHz is also allocated to the space operation service (Earth-to-space) on a primary basis, subject to agreement obtained under No. 9.21. The bandwidth of any individual transmission shall not exceed ±25 kHz.

5.219 The use of the band 148-149.9 MHz by the mobile-satellite service is subject to coordination under No. 9.11A. The mobile-satellite service shall not constrain the development and use of the fixed, mobile and space operation services in the band 148-149.9 MHz.

5.223 Recognizing that the use of the band 149.9-150.05 MHz by the fixed and mobile services may cause harmful interference to the radionavigation-satellite service, administrations are urged not to authorize such use in application of No. 4.4.

US319 In the bands 137-138 MHz, 148-149.9 MHz, 149.9-150.05 MHz, 399.9-400.05 MHz, 400.15-401 MHz, 1610-1626.5 MHz, and 2483.5-2500 MHz, Federal stations in the mobile-satellite service shall be limited to earth stations operating with non-Federal space stations.

US320 The use of the bands 137-138 MHz, 148-150.05 MHz, 399.9-400.05 MHz, and 400.15-401 MHz by the mobile-satellite service is limited to non-voice, non-geostationary satellite systems and may include satellite links between land earth stations at fixed locations.

US244 The band 136-137 MHz is allocated to the non-Federal aeronautical mobile (R) service on a primary basis, and is subject to pertinent international treaties and agreements. The frequencies 136, 136.025, 136.05, 136.075, 136.1, 136.125, 136.15, 136.175, 136.2, 136.225, 136.25, 136.275, 136.3, 136.325, 136.35, 136.375, 136.4, 136.425, 136.45, and 136.475 MHz are available on a shared basis to the Federal Aviation Administration for air traffic control purposes, such as automatic weather observation stations (AWOS), automatic terminal information services (ATIS), flight information services-broadcast (FIS-B), and airport control tower communications.

US323 In the band 148-149.9 MHz, no individual mobile earth station shall transmit on the same frequency being actively used by fixed and mobile stations and shall transmit no more than 1% of the time during any 15 minute period; except, individual mobile earth stations in this band that do not avoid frequencies actively being used by the fixed and mobile services shall not exceed a power density of −16 dBW/4 kHz and shall transmit no more than 0.25% of the time during any 15 minute period. Any single transmission from any individual mobile earth station operating in this band shall not exceed 450 ms in duration and consecutive transmissions from a single mobile earth station on the same frequency shall be separated by at least 15 seconds. Land earth stations in this band shall be subject to electromagnetic compatibility analysis and coordination with terrestrial fixed and mobile stations.

US325 In the band 148-149.9 MHz fixed and mobile stations shall not claim protection from land earth stations in the mobile-satellite service that have been previously coordinated; Federal fixed and mobile stations exceeding 27 dBW EIRP, or an emission bandwidth greater than 38 kHz, will be coordinated with existing mobile-satellite service space stations.

G30 In the bands 138-144 MHz, 148-149.9 MHz, and 150.05-150.8 MHz, the fixed and mobile services are limited primarily to operations by the military services.

Appendix 2 – FCC Database Results

IBFS, ULS, and OET ELS

Table A2.1 - IBFS Data (137-138 MHz, 148-149.9 MHz)						
File Number	Applicant Name	Callsign	Frequency Band (MHz)	Last Action	Date Expire	AFFPN Date
SAT-AMD-20120809-00125	ORBCOMM License Corp.	S2103	137- 137	Dismissed by Delegated Authority	4/30/2025	8/31/2012
SAT-AMD-20120809-00125	ORBCOMM License Corp.	S2103	137- 138	Dismissed by Delegated Authority	4/30/2025	8/31/2012
SAT-AMD-20120809-00125	ORBCOMM License Corp.	S2103	138- 138	Dismissed by Delegated Authority	4/30/2025	8/31/2012
SAT-AMD-20140116-00006	ORBCOMM License Corp.	S2103	137- 137	Grant of Authority		2/7/2014
SAT-AMD-20140116-00006	ORBCOMM License Corp.	S2103	137- 138	Grant of Authority		2/7/2014
SAT-AMD-20140116-00006	ORBCOMM License Corp.	S2103	138- 138	Grant of Authority		2/7/2014
SAT-AMD-20150420-00027	ORBCOMM License Corp.	S2103	137- 137	Grant of Authority		5/22/2015
SAT-AMD-20150420-00027	ORBCOMM License Corp.	S2103	137- 138	Grant of Authority		5/22/2015
SAT-AMD-20150420-00027	ORBCOMM License Corp.	S2103	138- 138	Grant of Authority		5/22/2015
SAT-LOA-19940906-00051	LEO ONE WORLDWIDE, INC.	S2145	137- 137	Surrender of Authorization		8/3/1999
SAT-LOA-19941116-00088	FINAL ANALYSIS COMMUNICATION SERVICES, INC.	S2150	137- 139	Revocation of License or Authorization		11/25/1994
SAT-MOD-19990318-00029	ORBCOMM License Corp.	S2103	137- 137	Grant of Authority		4/27/1999
SAT-MOD-19990318-00029	ORBCOMM License Corp.	S2103	138- 138	Grant of Authority		4/27/1999
SAT-MOD-20070531-00076	ORBCOMM License Corp.	S2103	137- 137	Grant of Authority	4/30/2025	10/5/2007

SAT-MOD-20070531-00076	ORBCOMM License Corp.	S2103	137- 138	Grant of Authority	4/30/2025	10/5/2007
SAT-MOD-20070531-00076	ORBCOMM License Corp.	S2103	138- 138	Grant of Authority	4/30/2025	10/5/2007
SAT-MOD-20110801-00141	ORBCOMM License Corp.	S2103	137- 137	Dismissed by Delegated Authority		
SAT-MOD-20110801-00141	ORBCOMM License Corp.	S2103	137- 138	Dismissed by Delegated Authority		
SAT-MOD-20110801-00141	ORBCOMM License Corp.	S2103	138- 138	Dismissed by Delegated Authority		
SAT-MOD-20111021-00207	ORBCOMM License Corp.	S2103	137- 137	Granted in Part / Dismissed in Part	4/30/2025	12/2/2011
SAT-MOD-20111021-00207	ORBCOMM License Corp.	S2103	137- 138	Granted in Part / Dismissed in Part	4/30/2025	12/2/2011
SAT-MOD-20111021-00207	ORBCOMM License Corp.	S2103	138- 138	Granted in Part / Dismissed in Part	4/30/2025	12/2/2011
SAT-MOD-20150408-00019	**Terra Bella Technologies Inc.**	S2862	137- 138	Grant of Authority	12/16/2028	5/1/2015
SAT-MOD-20150408-00019	**Terra Bella Technologies Inc.**	S2862	138- 138	Grant of Authority	12/16/2028	5/1/2015
SAT-STA-20070919-00127	ORBCOMM License Corp.		137- 137	Dismissed by Delegated Authority		
SAT-STA-20070919-00127	ORBCOMM License Corp.		137- 138	Dismissed by Delegated Authority		
SAT-STA-20070919-00127	ORBCOMM License Corp.		138- 138	Dismissed by Delegated Authority		
SES-MOD-20060106-00014	ORBCOMM License Corp.	E940534	137- 138	Grant of Authority	6/12/2020	1/25/2006
SES-MOD-20130930-00853	ORBCOMM License Corp.	E940535	137- 401	Grant of Authority	6/12/2020	11/6/2013
SES-MOD-20130930-00854	ORBCOMM License Corp.	E940537	137- 401	Grant of Authority	5/17/2020	11/6/2013
SES-MOD-20130930-00855	ORBCOMM License Corp.	E940538	137- 401	Grant of Authority	5/17/2020	11/6/2013
SES-MOD-20130930-00856	ORBCOMM License Corp.	E940536	137- 401	Grant of Authority	5/17/2020	11/6/2013

Table A2.2 IBFS Data (148-150 MHz)

File Number	Applicant Name	Callsign	Frequency Band (MHz)	Last Action	Date Expire	AFFPN Date
SAT-AMD-20120809-00125	ORBCOMM License Corp.	S2103	148- 150	Dismissed by Delegated Authority	04/30/2025	08/31/2012
SAT-AMD-20120809-00125	ORBCOMM License Corp.	S2103	150- 150	Dismissed by Delegated Authority	04/30/2025	08/31/2012
SAT-AMD-20140116-00006	ORBCOMM License Corp.	S2103	148- 150	Grant of Authority		02/07/2014
SAT-AMD-20140116-00006	ORBCOMM License Corp.	S2103	150- 150	Grant of Authority		02/07/2014
SAT-AMD-20150420-00027	ORBCOMM License Corp.	S2103	148- 150	Grant of Authority		05/22/2015
SAT-AMD-20150420-00027	ORBCOMM License Corp.	S2103	150- 150	Grant of Authority		05/22/2015
SAT-LOA-19940906-00051	LEO ONE WORLDWIDE, INC.	S2145	148- 150	Surrender of Authorization		08/03/1999
SAT-LOA-19941116-00088	FINAL ANALYSIS COMMUNICATION SERVICES, INC.	S2150	148- 150	Revocation of License or Authorization		11/25/1994
SAT-LOA-20000814-00139	Volunteers in Technical Assistance	S2424	150- 150	Dismissed at Applicant's Request		10/16/2000
SAT-MOD-19990318-00029	ORBCOMM License Corp.	S2103	148- 148	Grant of Authority		04/27/1999
SAT-MOD-19990318-00029	ORBCOMM License Corp.	S2103	149- 149	Grant of Authority		04/27/1999
SAT-MOD-19990318-00029	ORBCOMM License Corp.	S2103	149- 150	Grant of Authority		04/27/1999
SAT-MOD-20070531-00076	ORBCOMM License Corp.	S2103	148- 150	Grant of Authority	04/30/2025	10/05/2007

SAT-MOD-20070531-00076	ORBCOMM License Corp.	S2103	150- 150	Grant of Authority	04/30/2025	10/05/2007
SAT-MOD-20110801-00141	ORBCOMM License Corp.	S2103	148- 150	Dismissed by Delegated Authority		
SAT-MOD-20110801-00141	ORBCOMM License Corp.	S2103	150- 150	Dismissed by Delegated Authority		
SAT-MOD-20111021-00207	ORBCOMM License Corp.	S2103	148- 150	Granted in Part / Dismissed in Part	04/30/2025	12/02/2011
SAT-MOD-20111021-00207	ORBCOMM License Corp.	S2103	150- 150	Granted in Part / Dismissed in Part	04/30/2025	12/02/2011
SAT-MOD-20150408-00019	Terra Bella Technologies Inc.	S2862	148- 150	Grant of Authority	12/16/2028	05/01/2015
SAT-MOD-20150408-00019	Terra Bella Technologies Inc.	S2862	150- 150	Grant of Authority	12/16/2028	05/01/2015
SAT-STA-20070919-00127	ORBCOMM License Corp.		148- 150	Dismissed by Delegated Authority		
SAT-STA-20070919-00127	ORBCOMM License Corp.		150- 150	Dismissed by Delegated Authority		
SES-LIC-19940406-01536	ORBCOMM License Corp.	E940535	150- 150	Grant of Authority	06/12/2005	02/15/1995
SES-LIC-19940406-01537	ORBCOMM License Corp.	E940536	150- 150	Grant of Authority	05/17/2005	02/15/1995
SES-LIC-19940406-01538	ORBCOMM License Corp.	E940537	150- 150	Grant of Authority	05/17/2005	02/15/1995
SES-LIC-19940406-01539	ORBCOMM License Corp.	E940538	150- 150	Grant of Authority	05/17/2005	02/15/1995
SES-LIC-19940524-01329	ORBCOMM License Corp.	E940534	148- 150	Grant of Authority	06/12/2005	02/15/1995
SES-LIC-19961112-00199	SCIENTIFIC-ATLANTA, INC.	E970140	148- 150	Grant of Authority		06/11/1997
SES-LIC-19961112-00200	SCIENTIFIC-ATLANTA, INC.	E970141	148- 150	Grant of Authority		06/11/1997

SES-MOD-20060106-00014	ORBCOMM License Corp.	E940534	148- 150	Grant of Authority	06/12/2020	01/25/2006
SES-MOD-20130930-00853	ORBCOMM License Corp.	E940535	150- 150	Grant of Authority	06/12/2020	11/06/2013
SES-MOD-20130930-00854	ORBCOMM License Corp.	E940537	150- 150	Grant of Authority	05/17/2020	11/06/2013
SES-MOD-20130930-00855	ORBCOMM License Corp.	E940538	150- 150	Grant of Authority	05/17/2020	11/06/2013
SES-MOD-20130930-00856	ORBCOMM License Corp.	E940536	150- 150	Grant of Authority	05/17/2020	11/06/2013
SES-RWL-20050412-00437	ORBCOMM License Corp.	E940535	150- 150	Grant of Authority	06/12/2020	
SES-RWL-20050412-00438	ORBCOMM License Corp.	E940534	148- 150	Grant of Authority	06/12/2020	
SES-RWL-20050412-00439	ORBCOMM License Corp.	E940538	150- 150	Grant of Authority	05/17/2020	
SES-RWL-20050412-00440	ORBCOMM License Corp.	E940537	150- 150	Grant of Authority	05/17/2020	
SES-RWL-20050412-00441	ORBCOMM License Corp.	E940536	150- 150	Grant of Authority	05/17/2020	

Table A2.3 – OET Experimental Licensing System Data (136 – 150 MHz)										
File Number	**Call Sign**	**Applicant Name**	**Receipt Date**	**Status**	**Status Date**	**Site Address (or mobile)**	**State**	**County/ City**	**Fixed Coordinates**	**Frequency (relevant)**
0031-EX-CN-2017	WI2XTS	The Boeing Company	1/11/2017	Granted	3/9/2017	Mobile	Texas	San Antonio	North 29 22 29, West 98 34 22	136.97500000- MHz
0350-EX-CN-2017	WI2XXX	The BOEING Company	5/8/2017	Granted	6/1/2017	Boeing Field	Washington	King/ Seattle	North 47 30 54, West 122 17 34	136.00000000-136.97500000 MHz
						Paine Field	Washington	Snotomish/ Everett	North 47 53 49, West 122 16 45	136.00000000-136.97500000 MHz
0074-EX-CN-2018	WJ2XJY	Harris Corporation	1/29/2018	Granted	3/28/2018	Mobile: US: 1 km radius around airports	United States (All 50)		North, West	136.97500000- MHz
]0180-EX-CN-2018	WJ2XNE	ARINC Incorporated	2/20/2018	Granted	5/23/2018	2551 Riva Road	Maryland	Anne Arundel/ Annapolis	North 38 58 35, West 76 32 58	136.97500000- MHz
						Majors Airport	Texas	Hunt/ Greenville	North 33 4 30, West 96 4 35	136.97500000- MHz
0191-EX-CN-2016	WI2XQF	Lockheed Martin Corporation	11/3/2016	Granted	1/3/2017	3 miles north of Aztec in Yuma Country	Arizona	Yuma/ Aztec	North 32 52 0, West 113 26 9	138.00000000-139.50000000 MHz

0175-EX-CN-2017	WI2XVL	Quinteccent Inc	3/16/2017	Granted	7/28/2017	Mobile: Radium Springs, NM	New Mexico	Dona Ana/ Radium Springs	North 32 32 40, West 106 47 44	138.00000000-150.00000000 MHz, 150.00000000-225.00000000 MHz
0406-EX-CN-2017	WI2XZC	The Boeing Company	5/30/2017	Granted	10/5/2017	Boeing Facility Seattle, WA	Washington	King/ Seattle	North 47 30 59, West 122 18 1	138.00000000-224.90000000 MHz
0845-EX-CN-2017	WJ2XEX	L3 Technologies	11/2/2017	Granted	1/8/2018	Mobile: 30km radius of TSTC Waco, TX	Texas	Waco	North 31 38 16, West 97 4 27	138.05000000- MHz, 139.80000000- MHz,
0175-EX-CN-2017	WI2XVL	Quinteccent Inc	3/16/2017	Granted	7/28/2017	Mobile: Radium Springs, NM	New Mexico	Dona Ana/ Radium Springs	North 32 32 40, West 106 47 44	138.00000000-150.00000000 MHz, 150.00000000-225.00000000 MHz
0406-EX-CN-2017	WI2XZC	The Boeing Company	5/30/2017	Granted	10/5/2017	Boeing Facility Seattle, WA	Washington	King/ Seattle	North 47 30 59, West 122 18 1	138.00000000-224.90000000 MHz

Table A2.4 - ULS 136-138 MHz Data Set									
Call Sign/Lease ID	**Name**	**FRN**	**Radio Service**	**Status**	**Expiration Date**	**Location**	**Transmitter Address /Area of Operation**	**Latitude, Longitude**	**Frequency**
KAA4	Aviation Spectrum Resources Inc	13756952	AF	Active	3/1/2026	1 - Fixed	SPRINGFIELD REGIONAL AIRPORT, SPRINGFIELD, MO GREENE County	37-14-52.3 N, 093-22-46.2 W	136.975
KAF7	Aviation Spectrum Resources Inc	13756952	AF	Active	9/23/2019	2 - Fixed	LOS ANGELES INTL AIRPORT TERMINAL 2 GATE 24, LOS ANGELES, CA LOS ANGELES County	33-56-48.6 N, 118-24-14.8 W	136.975
KAG4	Aviation Spectrum Resources Inc	13756952	AF	Active	6/20/2025	3 - Fixed	LAFAYETTE REGIONAL AIRPORT, LAFAYETTE, LA LAFAYETTE County	30-12-41.2 N, 091-59-32.3 W	136.975
KAL9	Aviation Spectrum Resources Inc	13756952	AF	Active	4/12/2026	4 - Fixed	SEATTLE TACOMA INTERNATIONAL AIRPORT, SEATTLE, WA KING County	47-26-28.5 N, 122-17-43.4 W	136.975
KAM6	Aviation Spectrum Resources Inc	13756952	AF	Active	4/12/2019	5 - Fixed	SITE B: TERMINAL D LAS VEGAS INTL AIRPORT, LAS VEGAS, NV CLARK County	36-04-52.1 N, 115-08-10.4 W	136.975
KZB9	Alaska Aviation Radio, Inc. c/o John L Bartlett	1571504	AF	Active	8/23/2019	1 - Mobile	Mobile: Other Area of Operation: STATEWIDE AK		136.525-136.975

WRAD881	Embraer Engineering & Technology Center	26659987	AF	Active	10/20/2027	1 - Mobile	Mobile: Operating within a 2.0 km radius around 28-06-30.6 N , 080-38-39.5 W, Melbourne, FL BREVARD County	28-06-30.6 N, 080-38-39.5 W	136.975
WPYG870	ALASKA, STATE OF	1567247	YW	Active	8/8/2023	1 - Fixed	550 W. 7TH AVENUE ANCHORAGE, AK ANCHORAGE County	61-12-55.0 N, 149-53-38.9 W	138.3875-140.7875
						2 - Fixed	12 MILES NORTHEAST OF ANCHORAGE ANCHORAGE, AK ANCHORAGE County	61-15-29.0 N, 149-31-45.0 W	
						3 - Fixed	DOT HWYS MAINT.COMPOUND AT INT.OF PEGER & DAVIS RO FAIRBANKS, AK FAIRBANKS NORTH STAR County	64-49-32.0 N, 147-46-37.0 W	
						4 - Fixed	9.2 MILES WEST OF FAIRBANKS FAIRBANKS, AK	64-52-30.0 N, 148-03-58.0 W	

						5 - Fixed	AIH SAFETY BLDG ANCHORAGE INTERNAIONAL AIRPORT ANCHORAGE, AK ANCHORAGE County	61-10-57.0 N, 149-59-49.0 W	
						6 - Fixed	MILE 321 RICHARDSON HIGHWAY HARDING LAKE, AK	64-24-32.0 N, 146-56-54.0 W	
WQBM743	ALASKA, STATE OF	1567247	YW	Active	11/8/2024	1 - Fixed	2 MILES SOUTH OF COOPER LANDING COOPER LANDING, AK KENAI PENINSULA County	60-27-41.8 N, 149-48-41.6 W	138.0125-142.9875
						2 - Fixed	2 MILES NORTH OF FOX FAIRBANKS, AK FAIRBANKS NORTH STAR County	64-59-10.0 N, 147-35-53.4 W	
						3 - Fixed	AK RAILROAD YARD SEWARD, AK KENAI PENINSULA County	60-07-13.9 N, 149-25-32.7 W	

						4 - Fixed	1 MILE EAST OF SEWARD HWY, MP 18.7	60-20-34.9 N, 149-18-57.7 W	
							MOOSE PASS, AK KENAI PENINSULA County		
						5 - Fixed	CVTC RADIO SITE SLANA, AK VALDEZ-CORDOVA County	62-43-16.0 N, 144-02-26.0 W	
						6 - Fixed	MILE 2.0 POINT MAC KENZIE RD KINK, AK MATANUSKA-SUSITNA County	61-25-20.0 N, 149-52-28.0 W	
WQGB457	ALASKA, STATE OF	1567247	YW	Active	11/29/2026	1 - Temporary Fixed Special Condition	Statewide: AK		138.0375-138.7125
						2 - Temporary Fixed Special Condition	Statewide: AK		
						3 - Mobile Special Condition	Statewide: AK		

WQWY942	Minnesota Department of Public Safety	20369229	YW	Active	1/4/2026	1 - Fixed	Boise Cascade pulp yard. 1.6 KM East of HWY 11 International Falls, MN KOOCHICHING County	48-35-54.8 N, 093-22-32.2 W	138.165-138.975

KVZ742	ERIE, COUNTY OF	4474565	PW	Active	4/25/2024	1 - Fixed	462 GRIDER ST BUFFALO, NY ERIE County	42-55-32.2 N, 078-49-51.1 W	148.655
KB35161	DAVIS ELECTRONICS COMPANY INC	6178842	IG	Active	7/1/2023	1 - Mobile	Other		150-174
WNKH612	REDI CALL COMMUNICATIONS CO	2212082	IG	Active	11/17/2022	1 - Temporary Fixed	121.0 km radius around centerpoint	38-40-06.4 N, 075-22-35.7 W	150-174
						2 - Mobile	121.0 km radius around centerpoint	38-40-06.4 N, 075-22-35.7 W	
WNNH494	APPLIED TECHNOLOGY GROUP INC	1651009	IG	Active	1/6/2024	1 - Temporary Fixed	Statewide: CA		150-174
						2 - Mobile	Statewide: CA		
WRCA615	PMD Inc	27628262	IG	Active	8/9/2028	1 - Temporary Fixed	Continental US		150-174
						2 - Mobile	Continental US		
WRCA787	JVCKenwood USA Corporation	5743653	IG	Active	8/12/2018	1 - Mobile	2.0 km radius around centerpoint	36-07-53.0 N, 115-09-05.0 W	150-174
WRN355		1794700	IG	Active	9/15/2022	1 - Temporary Fixed	Other		150-174

	HIGHLAND COMMUNICATIONS, INC.					2 - Mobile	Other		

Notes:

1. For 0.5 MHz below 137 MHz, there were 640 active licenses, all to Aviation Spectrum Resources Inc., other than the two noted in the table A2.4 examples total have been provided.
2. For 0.5 MHz above 149.9 MHz, there were 276 active licenses, all to a variety of licensees. 6 examples have been provided