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Radio Spectrum Allocations 101

Presentation to

The National Academies

Board on Physics and Astronomy

Committee on Radio Frequencies

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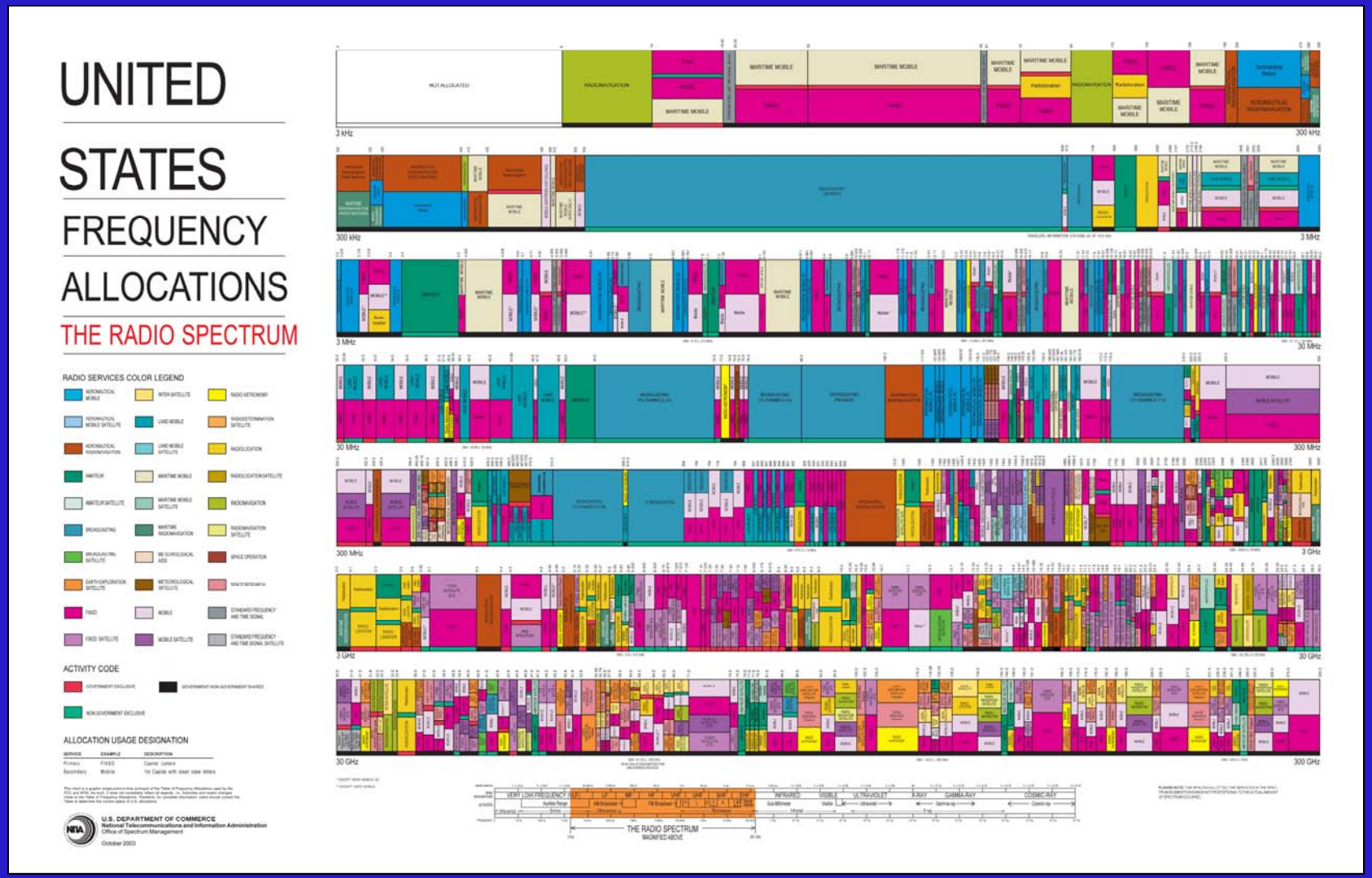

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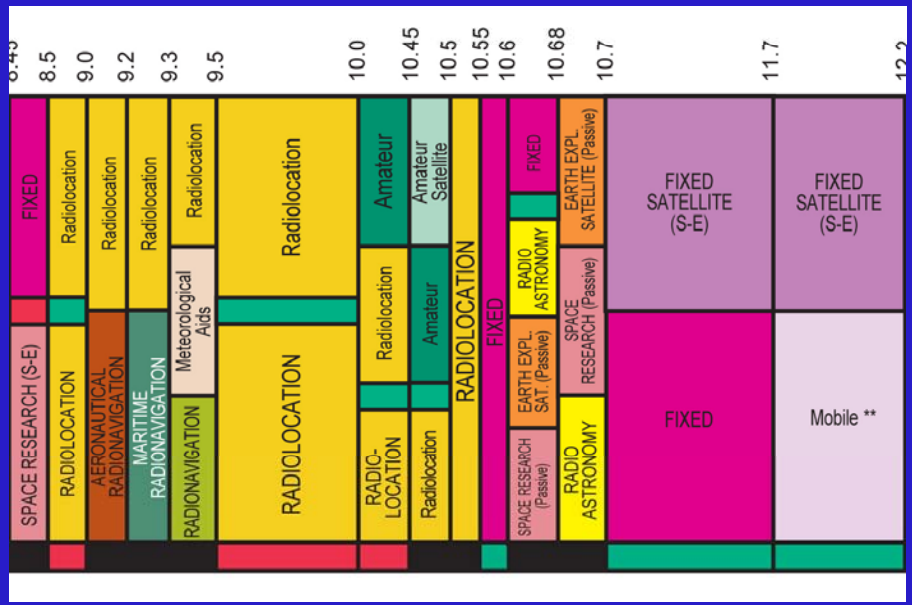
Purpose of Spectrum Allocations

- Spectrum allocations are comparable to zoning laws
  - > "Zoning" is by frequency instead of by geography
  - > Establishes what type of application can be deployed in each band
- Allocations are designed to accommodate one or more services in a particular band that are generally able to co-exist or at least coordinate their respective applications



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Regulation of Radio Spectrum in the U.S.

- **U.S. has a unique two-body spectrum regulatory structure**
  - > **National Telecommunications and Information Administration (NTIA) regulates spectrum use by Federal government agencies (including NSF, NASA, and NOAA)**
  - > **Federal Communications Commissions (FCC) regulates spectrum use by everyone else – private citizens, local and state governments, businesses, etc.**
- **International spectrum use is coordinated by the International Telecommunication Union (ITU)**

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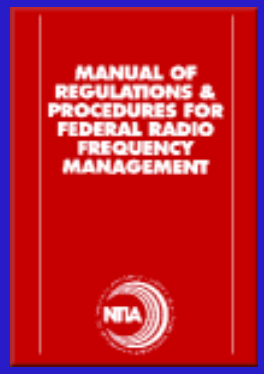
NTIA

- "[A]n agency in the U.S. Department of Commerce that serves as the executive branch agency principally responsible for advising the President on telecommunications and information policies. …In addition to representing the Executive Branch in both domestic and international telecommunications and information policy activities, NTIA also manages the Federal use of spectrum…"
- NTIA rules and regulations are contained within its *Manual of Regulations and Procedures for Federal Radio Frequency Management* (the "Redbook" or "NTIA Manual")
  - > www.ntia.doc.gov/osmhome/redbook/redbook.html
- Federal agencies advise the NTIA on spectrum matters through the Interdepartment Radio Advisory Committee (IRAC)
- Federal government spectrum allocations are contained in section 4.1 of the NTIA Manual.



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FCC

- "The FCC was established by the Communications Act of 1934 and is charged with regulating interstate and international communications by radio, television, wire, satellite, and cable. The FCC's jurisdiction covers the 50 states, the District of Columbia, and U.S. possessions."
  - The Act was amended in 1982 to give the Commission authority to regulate intrastate communications
- FCC's rules are contained within Title 47 of the Code of Federal Regulations (CFR)
  - www.nsma.org/CFR.htm
- FCC's spectrum allocations are contained within section 2.106 of Title 47 of the CFR
- Legal source document for FCC allocation is version published in the *Federal Register*
- Updated (but unofficial) spectrum allocations are available at www.fcc.gov/oet/spectrum/

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ITU

- ITU is a specialized agency of the United Nations
- Worldwide allocations are agreed upon by the 191 member administrations of the ITU
- ITU allocations are part of the *Radio Regulations*, an international treaty, and are established among the three ITU regions
- To the extent that any non-compliance with the ITU table does not cause interference to countries that abide by the table, each country is free to (and often does) modify the ITU table to suit its own needs.

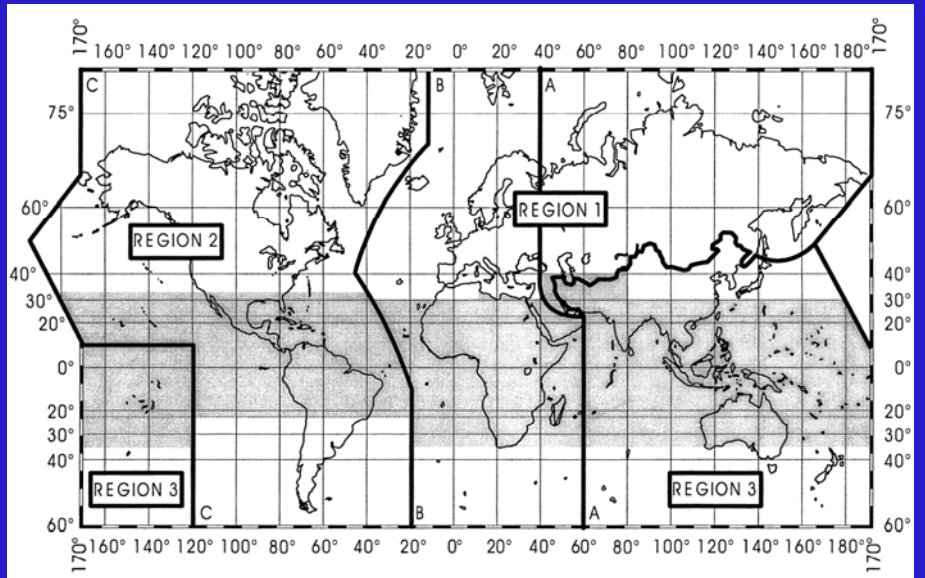

Figure 1: Map identifying Region 1, Region 2, and Region 3, as defined in paragraph 2.104(b), and the Tropical Zone (shaded area), as defined in paragraph 2.104(c)(4).

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Allocated Frequency Range

- The NTIA, FCC, and ITU define radio waves as "electromagnetic waves of frequency arbitrarily lower than 3,000 GHz, propagated in space without artificial guide"
- Allocations presently extend only to 275 GHz
  - 275 – 3,000 GHz is not allocated
- On the low side, allocations extend down to 9 kHz
  - 0 – 9 kHz is not allocated
- Almost all applications are below 100 GHz
- The vast majority of common spectrum use is below 30 GHz

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A Very Few Common Applications…

Application	Frequency or Frequency Range (~ denotes non-contiguous or approximate)
AM broadcast	530 kHz - 1.7 MHz
Broadcast television	54 ~ 88, 174 - 216, 470 ~ 698 MHz
FM broadcast	88 - 108 MHz
Cell phones	~750, ~850, ~1700, ~1950, ~2100 MHz
GPS (non-military)	~1.5 GHz
Satellite radio	~2.3 GHz
Wireless computer networks	~2.4 & ~5.8 GHz
Satellite TV	~12 GHz
Fixed point-to-point links	~1 ~ 90 GHz

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Band Designations

Frequency Range	Designation	Abbreviation
3 - 30 kHz	Very Low Frequency	VLF
30 - 300 kHz	Low Frequency	LF
300 - 3,000 kHz	Medium Frequency	MF
3 - 30 MHz	High Frequency	HF
30 - 300 MHz	Very High Frequency	VHF
300 - 3,000 MHz	Ultra High Frequency	UHF
3 - 30 GHz	Super High Frequency	SHF
30 - 300 GHz	Extremely High Frequency	EHF

IEEE Designator	Range
L-band	1 - 2 GHz
S-band	2 - 4 GHz
C-band	4 - 8 GHz
X-band	8 - 12 GHz
Ku-band	12 - 18 GHz
K-band	18 - 27 GHz
Ka-band	27 - 40 GHz
V-band	40 - 75 GHz
W-band	75 - 110 GHz

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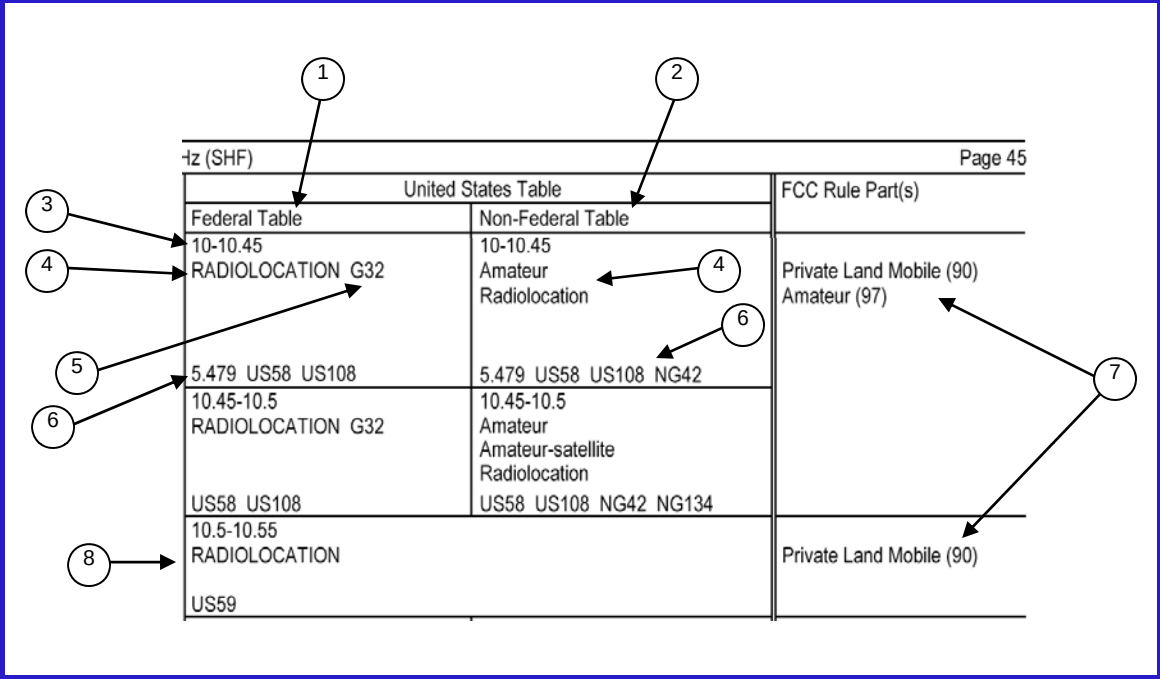
Allocation Table Example



1. **Column showing allocations by NTIA to Federal government agencies**
2. **Column showing allocations by FCC to non-Federal government users**
3. **Frequency range covered by this cell (10-10.45 GHz)**
4. **The service(s) to which this range is allocated**
5. **Footnote specific to one service**
6. **Footnotes that apply to the entire cell**
7. **FCC rule parts that apply to non-Federal allocations**
8. **When Federal and non-Federal allocations are the same, the cells are joined**

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Radio Services

- Spectrum use is broken down into 26 different allocated services for non-Federal applications, and 23 different services for Federal uses
- FCC, NTIA, and ITU define each service (definitions are the same across regulations)
- Companion document contains definitions and examples for each service

Aeronautical mobile	Inter-satellite	Radiodetermination-satellite
Aeronautical radionavigation	Land mobile	Radiolocation
Amateur*	Maritime mobile	Radionavigation
Amateur-satellite*	Maritime radionavigation	Radionavigation-satellite
Broadcasting	Meteorological aids	Space operation
Broadcasting-satellite*	Meteorological-satellite	Space research
Earth exploration-satellite	Mobile	Standard frequency and time signal
Fixed	Mobile-satellite	Standard frequency and time signal-satellite
Fixed-satellite	Radio astronomy	**Non-Federal use only*

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Allocation Status

- Each allocated service is generally granted either primary or secondary status
  - In the allocation table, services allocated on a primary basis are listed in all capital letters (“RADIOLOCATION”)
  - Services allocated on a secondary basis are listed in regular letters (“Radiolocation”)
- Relative spectrum rights are defined in the CFR, NTIA Manual, and Radio Regulations:
  - Stations of a secondary service:

    (i) Shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date;

    (ii) Cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date; and

    (iii) Can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date.

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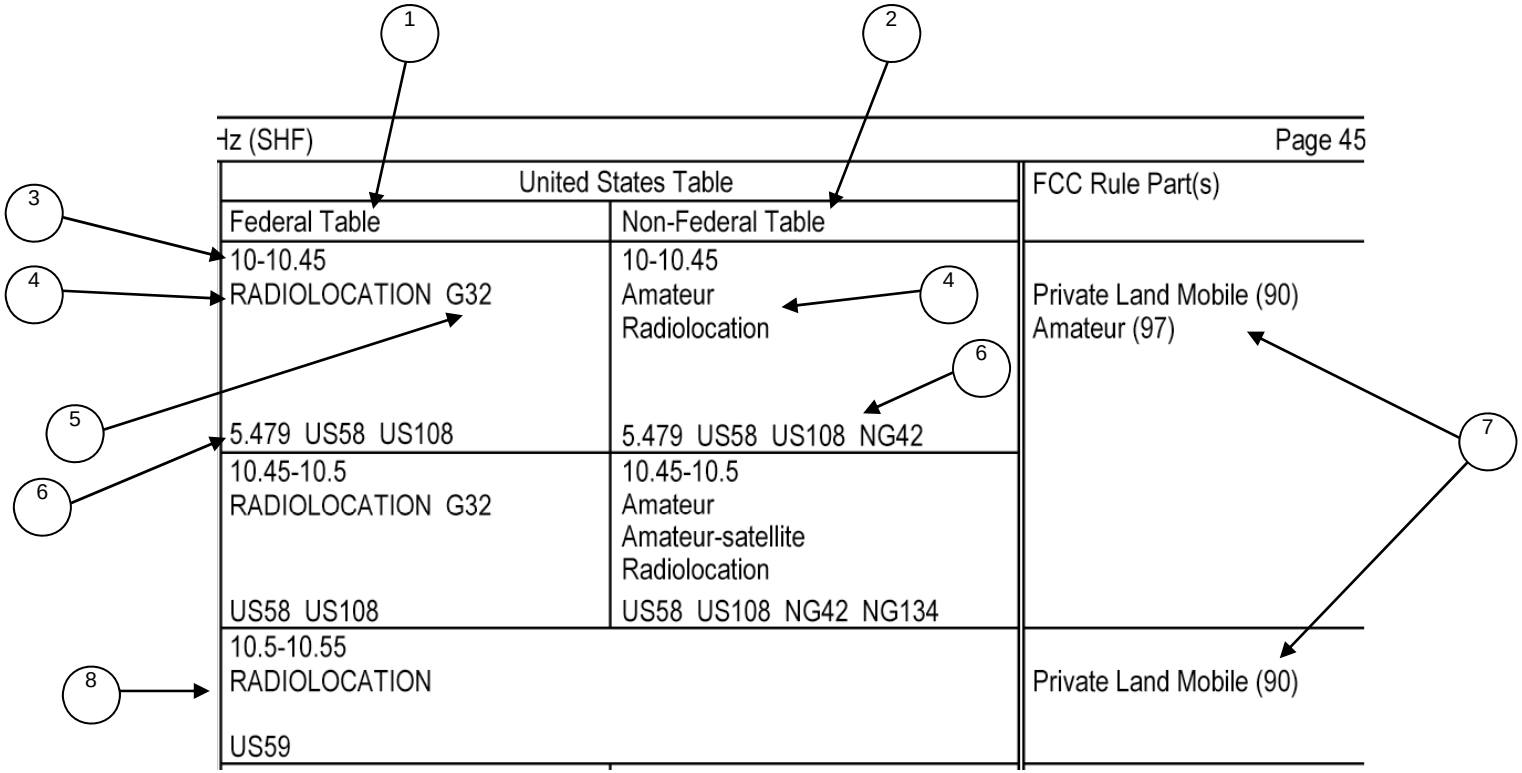

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United States Table		FCC Rule Part(s)
Federal Table	Non-Federal Table	
10-10.45 RADIOLOCATION G32 5.479 US58 US108	10-10.45 Amateur Radiolocation 5.479 US58 US108 NG42	Private Land Mobile (90) Amateur (97)
10.45-10.5 RADIOLOCATION G32 US58 US108	10.45-10.5 Amateur Amateur-satellite Radiolocation US58 US108 NG42 NG134	
10.5-10.55 RADIOLOCATION US59		Private Land Mobile (90)

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Allocation Footnotes

- Footnotes to the allocation table are important considerations
- There can be as much or more information in the footnotes than there is in the table itself
- Among other things, footnotes can place significant restrictions on allocations, make additional allocations that don't appear in the table, or add geographically-specific considerations
- Footnotes come in several flavors:
  - 5.xxx: ITU footnotes that have been adopted in the FCC and/or NTIA tables
  - USxxx: Footnotes that apply to both Federal and non-Federal allocations
  - NGxxx: Footnotes that apply only to non-Federal allocations
  - Gxxx: Footnotes that apply only to Federal government allocations

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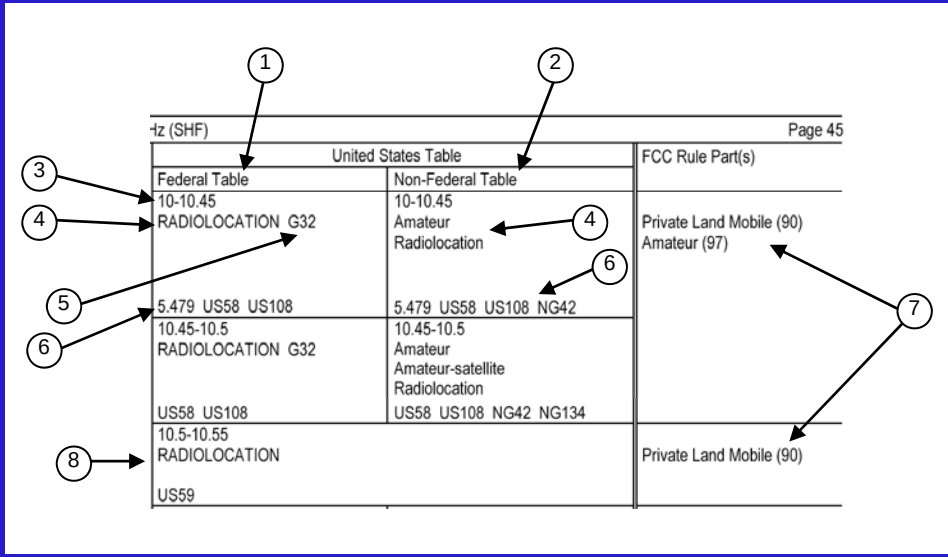

- **5.479 The band 9975-10025 MHz is also allocated to the meteorological-satellite service on a secondary basis for use by weather radars.**
- **G32 Except for weather radars on meteorological satellites in the band 9975-10025 MHz and for Federal survey operations (see footnote US108), Federal radiolocation in the band 10-10.5 GHz is limited to the military services.**
- **NG42 In the band 10-10.5 GHz, non-Federal stations in the radiolocation service shall not cause harmful interference to the amateur service.**
- **US58 In the band 10-10.5 GHz, pulsed emissions are prohibited, except for weather radars on board meteorological satellites in the band 10-10.025 GHz. The amateur service and the non-Federal radiolocation service, which shall not cause harmful interference to the Federal radiolocation service, are the only non-Federal services permitted in this band. The non-Federal radiolocation service is limited to survey operations as specified in footnote US108.**
- **US108 In the bands 3300-3500 MHz and 10-10.5 GHz, survey operations, using transmitters with a peak power not to exceed five watts into the antenna, may be authorized for Federal and non-Federal use on a secondary basis to other Federal radiolocation operations.**

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Summary

- Radio spectrum allocations in the U.S. are the result of rules and regulations promulgated by the NTIA (for Federal government users) and the FCC (for all other).
- The ITU develops spectrum allocations on a worldwide basis, which may or may not be adopted by an individual country.
- Allocations usually provide for orderly use of the radio spectrum and a general expectation of the RF environment that may be encountered in a particular band.
- Every frequency between 9 kHz and 275 GHz is allocated to one or more of the 26 defined radio services.
- Footnotes to the allocation table add important information to what's presented in the table itself.