MASTER FILE SEARCH (MFS)

- An Analytical Tool For The Spectrum Manager

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Abstract

The Spectrum Survey and Analysis Branch of the Spectrum Allocation Division of the Office of Chief Engineer within the Federal Communications Commission (FCC) has developed a computerized retrieval system for license information. This paper discusses this FORTRAN-based system which runs on the FCC's UNIVAC 1106 computer. The Master File Search (MFS) system contains over 1.2 million records covering all non-Government frequency assignments except for citizens and amateur licenses. The records contain technical information such as frequency, power, emission type(s), antenna height, station coordinates, etc., as well as some non-technical information such as call sign, service code, class code, etc. The paper, by way of sample queries, demonstrates the utility of the system as an analytical tool helping the spectrum manager solve spectrum allocation problems. The paper also discusses the limitations of the system and examines some of the future enhancements which will be made to the MFS.

Introduction

Most people are familiar with the automated reservation systems utilized by travel agencies, airline ticket personnel and hotels. Imagine the delays and confusion if such a system had not been developed, especially with today's heavy volume of air travel. Some planes would be seriously overbooked, travel agents could not give up-to-the minute flight information, and in general, the entire commercial aviation industry would be unmanageable. Fortunately such a system does exist which prevents gross overbooking and provides timely occupancy information to consumers and managers in the travel industry.

What does the airline and hotel businesses have to do with communications? The same tools which these businesses use to manage their limited resources can be applied to the managing of the electromagnetic spectrum. Just as an airplane or hotel can hold only so many people before a congestion problem develops, so too a radio channel can become overbooked (overassigned) to the point of becoming virtually useless as a means of communications. To gain a handle on the current state of occupancy of various portions of the spectrum an automated system of retrieving license information is needed. This is where the Master File Search system can help.

The Master File Search (MFS) system was developed to provide the spectrum manager with statistics on how various channels are being assigned. It should be noted that unlike an airplane or hotel which has a predetermined upper limit on its capacity, a communications channel may show a large number of assignments, possibly indicating an ineffective means of communication, but due to geographic spacing and/or time-sharing the channel is indeed a useful means of communication. While the MFS system cannot now determine if a channel is ineffective as a communications link, it provides the capability of making relative channel assignment comparisons.

The MFS System

In recent years, information such as how many transmitters are licensed within a particular frequency range could only be obtained by counting assignments on reams of computer output. If a finer distinction were needed such as how are these transmitters distributed among the top twenty-five (25) Standard Metropolitan Statistical Areas (SMSA), only a small sample could be obtained. This manner of data gathering was not adequate for the types of spectrum analysis work which is needed for making decisions for new allocations. The use of the digital computer greatly alleviated the manual search of the license records, but because of the size of the file (at one time this file was spread across forty-five (45) reels of magnetic tape) processing was still cumbersome. Presently, the FCC records show close to 1.2 million frequencies in use. Nominally twenty-six (26) different pieces of information, such as licensee name, address, call sign, etc. are maintained for each of these frequencies. Using this conservative figure over thirty-one million pieces of information are stored in the FCC list of frequency assignments. This list is commonly referred to as the master frequency file or the MFF. Ideally, one would like to have all this information available to the spectrum manager through an on-line (disk) automated information retrieval system. However, due to equipment limitations the MFS system contains a subset of the information stored in the MFF. The data elements which are included in the MFS system are enumerated in Table 1. This table represents those elements which are readily available from the MFF and which

appear to be of most value to the spectrum manager.

To access the data in the MFS system, a series of FORTRAN computer programs were written which provide a query capability. These programs may be run in either the time-sharing (demand) mode or the batch mode. In the time-sharing mode, the user is guided through the program through a series of menu type selections. Queries can be made on three (3) basic parameters. These parameters are frequency, geographic area and data. Under the frequency parameter, the data in the MFS system can be extracted on discrete frequencies, such as 450.1 megahertz (MHz) or 10.2 gigahertz (GHz), up to three hundred (300) individual frequencies, or on frequency bands, such as 450.0 to 470.0 MHZ or 10.2 to 10.3 GHz, up to one hundred fifty (150) bands. Also provisions have been made for selecting frequencies based on service (e.g. base or mobile) and/or class (e.g. business or cable television) designations. Under the area specification there are several ways in which to describe a geographic area. The four (4) coordinate points of a rectangle may be specified, a circle of center, x, y, (x, y are the coordinate values) and radius, r, (r is the number of miles around the center) may be described, areas may be chosen by state, state and county pairs, SMSA code and lastly, above or below the line used for Canadian frequency coordination (Line A). Under the date specification parameter license information may be selected by authorization or expiration date of the license. These three searching parameters provide a broad range of criteria on which to retrieve frequency assignment information.

How the MFS System Can Be Used as a Tool by the Spectrum Manager

Rather than give a tutorial on how one would use the MFS system, the remainder of this paper will look at queries which have been run to demonstrate the utility of this system as a spectrum analysis tool. For detailed information concerning using the MFS system the reader may consult reference 1 at the end of the paper.

Since much of the frequency spectrum is used in one way or another, most requests for new frequency allocations translate into requests for reallocation of existing frequency bands. Reallocation of the frequency spectrum leaves the spectrum manager with the following choices:

1) deny the reallocation request;
2) try to accommodate the reallocation request through sharing of the frequency spectrum with existing users;
3) accommodate the reallocation request by moving the current users out of the requested band.

Before the spectrum manager can decide on which course of action to take, an analysis of the particular request must be performed. Usually a request such as this comes to the FCC in a petition for rule making which is a formal statement of the intended use of the frequency spectrum. It is the responsibility of the spectrum manager to review these petitions making certain that the intended use is in the public interest. The queries which follow are examples which the spectrum manager might perform during the course of an analysis.

Sample Queries

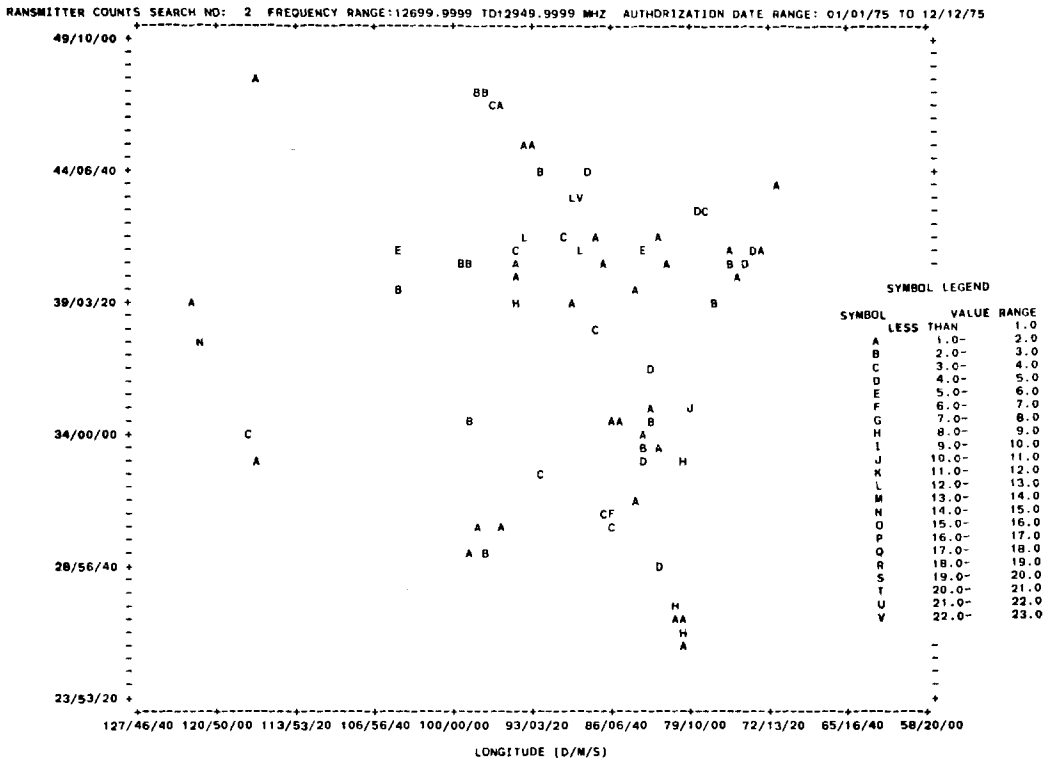
The following queries were done solely for purposes of demonstration. Each query is designed to point out a specific feature of the MFS system, however, they are typical of the types of queries which have been made since the system became operational. Sample 1 shows a listing of stations which operate in the 12.75 - 12.75 GHz band in the New York City Standard Metropolitan Statistical Area. Sample 2 shows a plot of stations licensed between January 1, 1975 and December 12, 1975 for the band 12.7 - 12.95 GHz and located within the continental United States. Sample 3 is another way of representing this same information only this time in a tabular form. Sample 4 shows a continental U.S. plot of the stations in the 12.7 - 12.95 GHz band authorized between January 1, 1975 and March 31, 1979. Comparing this plot with the one shown in Sample 2 reveals a marked increase in the number of stations in this short period of time. The asterisks (*) on the later plot signifies those areas with more than twenty-five (25) stations. These areas appear to be major cities such as New York, Los Angeles and Chicago.

Sample 1

INTERNATIONAL & OPERATIONS DIVISION PRINT FORMAT - SEARCH: 1

RECORD # / LATITUDE	FREQUENCY / LONGITUDE	SVC / EMISSION(S)	CALL	T	ST	XMTR POWER	COUNTY	FID GR	EL	ATD ANT	EXD UNITS	CLASS REC ID
1	M12754.5000-	TR	WDC400	L	NY		ROCKLAND	053178	053178	050183		CAR
41-06-50	N 074-04-40 W	M	5.75A5C			W	5.000	X	0	150	0	1205480
2	M12754.5000-	TR	WDC400	L	NY		ROCKLAND	053178	053178	050183		CAR
41-06-50	N 074-04-40 W	K	250.00F3			W	5.000	X	0	150	0	1205481
3	M12759.7001-	TR	WQL62	L	NY		NEW YORK	062973	062973	020176		
00-00-00	N 000-00-00 W					K	.000	I	0	0	0	1205515
4	M12766.5000-	TR	WDC400	L	NY		ROCKLAND	053178	053178	050183		CAR
41-06-50	N 074-04-40 W	M	5.75A5C			W	5.000	X	0	150	0	1205588
5	M12766.5000-	TR	WDC400	L	NY		ROCKLAND	053178	053178	050183		CAR
41-06-50	N 074-04-40 W	K	250.00F3			W	5.000	X	0	150	0	1205589
6	M12775.0000-	TR	WJC47	L	NJ		BERGEN	112376	112376	020181		CAR
40-57-39	N 073-55-23 W	M	24.90F9			U	250.000	X	0	0	0	1205687
7	M12775.0000-	TR	WJC51	L	NJ		BERGEN	121676	121676	020181		CAR
40-57-39	N 073-55-23 W	M	24.90F9			U	250.000	X	0	416	0	1205688
8	M12775.0000-	TR	WIC61	L	NY		NASSAU	113076	113076	020181		CAR
40-41-08	N 073-36-37 W	M	25.00F9			W	1.000	X	0	0	0	1205694
9	M12775.0000-	TR	WIC61	L	NY		NASSAU	101277	101277	020181		CAR
40-41-08	N 073-36-37 W	M	25.00F9			W	1.000	X	0	333	0	1205695
10	M12777.7001-	TR	WQL62	L	NY		NEW YORK	062973	062973	020176		CAR
40-47-34	N 073-58-15 W	M	5.75A5C			U	100.000	I	0	0	0	1205769
11	M12777.7001-	TR	WQL62	L	NY		NEW YORK	062973	062973	020176		CAR
40-47-34	N 073-58-15 W	K	250.00F3			U	100.000	I	0	0	0	1205770
12	M12778.5000-	TR	WDC400	L	NY		ROCKLAND	053178	053178	050183		CAR
41-06-50	N 074-04-40 W	M	5.75A5C			W	5.000	X	0	150	0	1205779
13	M12778.5000-	TR	WDC400	L	NY		ROCKLAND	053178	053178	050183		CAR
41-06-50	N 074-04-40 W	K	250.00F3			W	5.000	X	0	150	0	1205780
14	M12800.0001-	TR	WJV31	L	NY		NASSAU	021473	021473	020176		CAR
40-42-58	N 073-36-09 W	M	25.00F9			U	615.000	I	0	0	0	1205951
15	M12820.5000-	TR	WHW60	L	NY		NEW YORK	032175	032175	020178		CAR
40-50-52	N 073-56-08 W	M	5.75A5C			W	1.000	X	0	0	0	1206146
16	M12820.5000-	TR	WHW60	L	NY		NEW YORK	032175	032175	020178		CAR
40-50-52	N 073-56-08 W	K	250.00F3			W	1.000	X	0	0	0	1206147
17	M12825.0000-	TR	WDW70	L	NY		NEW YORK	113076	113076	020181		CAR
40-46-08	N 073-58-55 W	M	25.00F9			W	1.000	X	0	0	0	1206261
18	M12868.5000-	TR	WDC400	L	NY		ROCKLAND	053178	053178	050183		CAR
41-06-50	N 074-04-40 W	M	5.75A5C			W	5.000	X	0	150	0	1206658
19	M12868.5000-	TR	WDC400	L	NY		ROCKLAND	053178	053178	050183		CAR
41-06-50	N 074-04-40 W	K	250.00F3			W	5.000	X	0	150	0	1206659
20	M12875.0000-	TR	WIC61	L	NY		NASSAU	113076	113076	020181		CAR
40-41-08	N 073-36-37 W	M	25.00F9			W	1.000	X	0	0	0	1206738
21	M12875.0000-	TR	WIC61	L	NY		NASSAU	101277	101277	020181		CAR
40-41-08	N 073-36-37 W	M	25.00F9			W	1.000	X	0	333	0	1206739
22	M12875.0000-	TR	WDW70	L	NY		NEW YORK	113076	113076	020181		CAR
40-46-08	N 073-58-55 W	M	25.00F9			W	1.000	X	0	0	0	1206740
23	M12879.7001-	TR	WQL62	L	NY		NEW YORK	062973	062973	020176		CAR
40-47-34	N 073-58-15 W	M	5.75A5C			U	100.000	I	0	0	0	1206814
24	M12879.7001-	TR	WQL62	L	NY		NEW YORK	062973	062973	020176		CAR
40-47-34	N 073-58-15 W	K	250.00F3			U	100.000	I	0	0	0	1206815
25	M12886.5000-	TR	WDC400	L	NY		ROCKLAND	053178	053178	050183		CAR
41-06-50	N 074-04-40 W	M	5.75A5C			W	5.000	X	0	150	0	1206842

SAMPLE 2

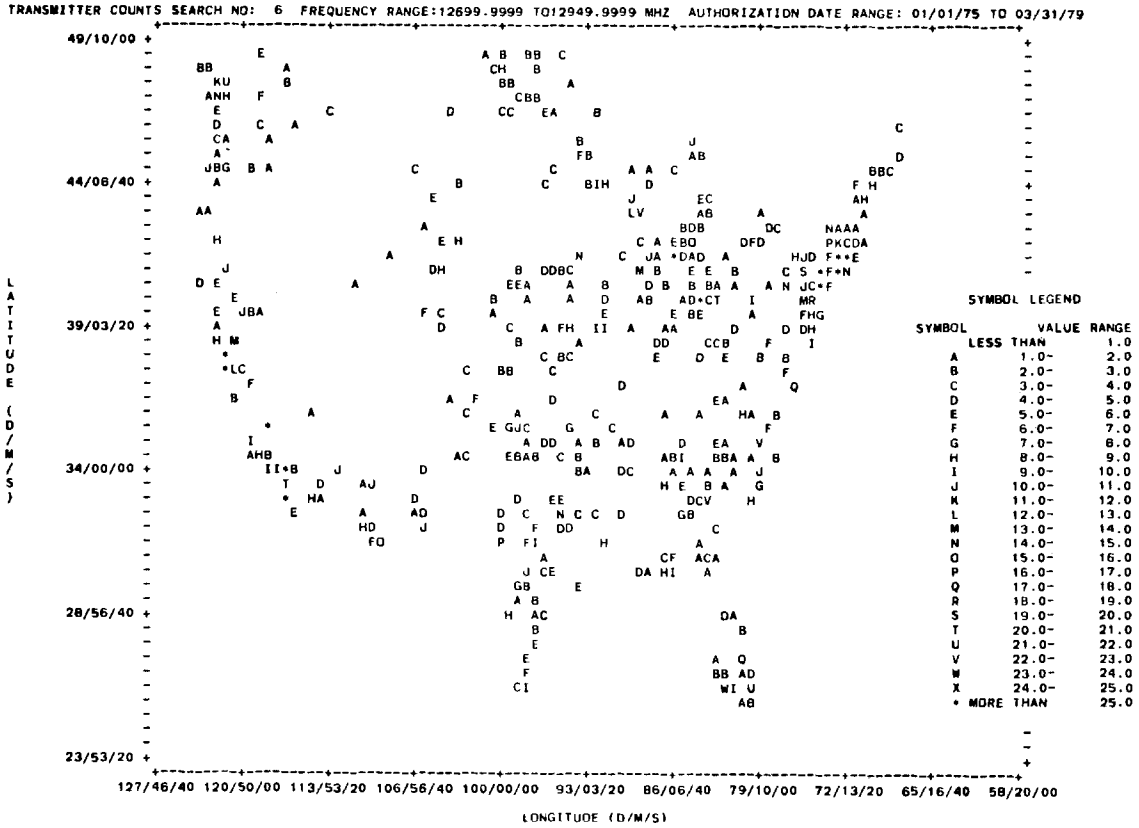


SAMPLE 3

TRANSMITTER COUNTS SEARCH NO: 2 FREQUENCY RANGE:12699.9999 TO12949.9999 MHZ AUTHORIZATION DATE RANGE: 01/01/75 TO 12/12/75

	LONGITUDE (D/M/S)																							TOTALS
	127 48 40	125 0 0	122 13 20	119 26 40	116 40 0	113 53 20	111 6 40	108 20 0	105 33 20	102 46 40	100 0 0	97 13 20	94 26 40	91 40 0	88 53 20	86 6 40	83 20 0	80 33 20	77 46 40	75 0 0	72 13 20	69 26 40	66 40 0	63 53 20	61 6 40	58 20 0	
49/10/00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48/09/20	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
47/08/40	0	0	0	0	0	0	0	0	0	0	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
46/08/00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45/07/20	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
44/06/40	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	0	0	0	0	0	1	0	0	0	0	0	7
43/06/00	0	0	0	0	0	0	0	0	0	0	0	0	0	12	22	0	0	4	3	0	0	0	0	0	0	0	41
42/05/20	0	0	0	0	0	0	0	0	0	0	0	0	12	3	1	0	1	0	0	0	0	0	0	0	0	0	17
41/04/40	0	0	0	0	0	0	0	0	5	0	4	0	4	0	13	0	6	0	3	9	0	0	0	0	0	0	44
40/04/00	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	5
39/03/20	0	1	0	0	0	0	0	0	0	0	0	0	8	1	0	0	0	0	2	0	0	0	0	0	0	0	12
38/02/40	0	0	14	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	17
37/02/00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4
36/01/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35/00/40	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	3	10	0	0	0	0	0	0	0	0	17
34/00/00	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	7
32/59/20	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	4	8	0	0	0	0	0	0	0	0	16
31/58/40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
30/58/00	0	0	0	0	0	0	0	0	0	0	1	1	0	0	3	9	0	0	0	0	0	0	0	0	0	0	14
29/57/20	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
28/56/40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4
27/56/00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	8
26/55/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	10
25/54/40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
24/54/00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23/53/20 TOTALS	0	1	14	5	0	0	0	0	7	0	10	9	32	16	46	13	26	41	8	10	1	0	0	0	0	0	239

SAMPLE 4



The Next Generation of the MFS System

As experience is gained with the MFS system, suggestions have been made regarding improvements for the system. Some of these improvements are in the area of making the MFS system more "human" in detecting and, where possible, correcting errors. Other suggestions have been directed toward pointing out some of the limitations of the system. These suggestions are welcome and some have been already implemented.

The MFS system was created in a modular fashion. Because of this building block approach it is amenable to change without massive redesign or recoding. Some of the improvements which will soon be available through the system is the ability to query information found in the FCC Table of Frequency Allocations. The Table of Frequency Allocations currently exists as a separate query program (reference 2) and its incorporation into the MFS system will tie allocation and assignment information together. Another improvement which will be forthcoming is the ability to query the license file on service and class codes. This summer a project will be started to include the date when a station was first licensed to operate. This information will give the spectrum manager the ability to develop time-series analyses and to project future loading characteristics of various portions of the frequency spectrum. Some of the long range goals include the addition of license information from sources other than the non-Government sector such as Government assignments, Canadian and Mexican stations.

Data Integrity - A Caveat

There are several problems regarding the integrity of the data stored on the MFS system which should be noted. Records which reflect mobile assignments do not in general have coordinate information. Because of this situation, queries using a geographic description such as a rectangle or a circle will not retrieve these records. There is a problem with some records appearing more than once on the file. This condition arises when an update procedure is in error causing duplicate records to be left on the file. Also, assignments such as television broadcast stations may appear more than once because of the convention of storing the two powers (visual and aural) in two separate records. In conclusion, there is a problem with keystroking errors which of course means lost information. In our work we have been able to detect most errors, but can not correct them outside of going back to the source document which is the paper license. An analysis of the error problem is described in reference 3.

TABLE 1

SPECTRUM ALLOCATION DIVISION
COMPRESSED MASTER FREQUENCY FILE

RECORD LAYOUT

Item No.	Identification	Start Position (WORD/BITS)	Item Length (Bits)
1	Record ID	1/0	36
2	Frequency(10 Hz)	2/0	36
3	Call Sign (coded)	3/0	36
4	Latitude (USEC)	4/0	20
5	Original Issue Date (YMD)	4/20	16
6	Mobile units	5/0	14
7	Longitude (USEC)	5/14	21
8	RESERVED	5/35	1
9	Renewal/Issue Date (YMD)	6/0	16
10	Expiration Date (YMD)	6/16	16
11	Alaskan Zone Frequency	6/32	1
12	Band Edge Frequency	6/33	1
13	Special Call Sign	6/34	1
14	RESERVED	6/35	1
15	Power (uW)	7/0	14
16	Ground elevation (feet)	7/14	15
17	Service (coded)	7/29	7
18	Emission #1 (coded)	8/0	24
19	Antenna height (feet)	8/24	12
20	Emission #2 (coded)	9/0	24
21	Type of power (coded)	9/24	3
22	Class (coded)	9/27	8
23	RESERVED	9/35	1
24	State (coded)	10/0	7
25	County (coded)	10/7	12
26	Number of other emissions	10/19	3
27	Type of authorization	10/22	4
28	County overflow (HOB, coded)	10/26	2
29	RESERVED	10/28	2
30	Search Index (0 value)	10/30	6

Abbreviations used above:

10 Hz - value stored in 10 Hertz
coded - stored structure of the item is coded by some algorithm
USEC - value is stored in total seconds with a bit indicating the direction of the coordinate point, i.e. North, East, South, or West.
YMD - value is stored; year, month, day
feet - value stored in feet
uW - value stored in microwatts
HOB - high-order bits

REFERENCES

1. Tremper, Phillip G. and Cesaitis, Joseph V. Master File Search System MFS Users Guide. Washington, D.C.: Federal Communications Commission, FCC-OCE-SA-79-02

2. Cesaitis, Joseph V. An Automated Retrieval System for Frequency Allocation Information. Washington, D.C.: Federal Communications Commission, FCC-OCE-SA-79-01

3. Tremper, Phillip G., Survey of the non-Government Master Frequency File. Washington, D.C.: Federal Communications Commission, FCC-OCE-SA-78-01