HOSPITAL PROXIMITIES TO NEARBY BROADCAST STATIONS

Richard A. Tell, Donald L. Lambdin, and Edwin D. Mantiply
U.S. Environmental Protection Agency
Office of Radiation Programs
Electromagnetic Radiation Analysis Branch
P.O. Box 15027
Las Vegas, Nevada 89114

Abstract

A technique for identifying hospital locations which are potentially subject to high intensity radio-frequency fields from nearby broadcast stations is discussed. A medical care facilities data base representing 27 percent of all existing such facilities in the United States was used in conjunction with an automated broadcast station data base to determine and analyze distances between hospitals and nearby stations. It was determined that 20 percent of all hospitals are located within one mile of at least one FM broadcast station. The closest observed separation distance was 0.02 mile. Data are presented which allow determination of the fraction of hospitals having minimum separation distances $\leq$ various values for AM, FM, and TV stations. Information is provided on the number of such stations found within one mile of each hospital studied and the total effective radiated power of these stations.

Introduction

This paper reports on the use of computer automated data bases to examine the proximity of hospitals to nearby broadcast stations. The Environmental Protection Agency (EPA) has for several years endeavored to identify particular locations throughout the United States (US) which are potentially illuminated with high intensity radiofrequency fields in connection with EPA's program for evaluation of nonionizing radiation hazards. Previous studies have reported on several such identification techniques^{1,2,3,4} and this paper presents yet another approach to the problem.

Automated data bases of US broadcast stations and medical care facilities were prepared for convenient machine based analysis. The two data bases were then merged and an analysis was accomplished which identified hospital locations that were close to adjacent broadcast stations. Our use of a medical care facilities data base in demonstrating this identification procedure was prompted by the current interest in the electromagnetic compatibility (EMC) of medical devices commonly used in such facilities. Several investigators have studied the hospital electromagnetic field environment in particular^{5,6} with reference to device susceptibility. Vreeland et al.⁷ have examined the specific problem of broadcast fields from the standpoint of interference to cardiac pacemakers and interference with the operation of a digital electronic thermometer has been observed in the presence of strong FM radio-signals⁸. The Bureau of Medical Devices within the Food and Drug Administration (FDA), recognizing the apparent need for device EMC control, has recently developed an EMC standard for medical devices⁹ which prescribes among other things minimum radiated electric field susceptibility limits. A question of hospital proximity to broadcast transmitters plays an integral roll in the rationale for this part of the FDA EMC standard. This report presents data which is pertinent to the FDA's rationale.

Description of Data Bases

The broadcast station data base used in this analysis was obtained in several parts from the Federal Communications Commission (FCC). Separate data files were obtained and after a period of editing and merging a data base suitable for this analysis was developed. The separate data files obtained consisted of: (a) an AM engineering data base, (b) an FM engineering data base, (c) a TV engineering data base, and (d) the entire broadcast portion of the FCC Master File. To arrive at a useable file which contained unique records of broadcast stations which are actually on-the-air and which contained the necessary technical parameters for each station rather extensive editing of these separate files was performed. We used the engineering data bases as a fundamental building block because of their currency and general inclusion of technical data necessary for our analysis which is not maintained in the Master File. For example, the engineering data bases for each type of station, be it AM, FM, or TV contains information for stations which are in the process of applying for a license as well as those actually on the air and even entries for stations holding construction permits (CP). Records for stations other than those actually permitted to broadcast were deleted, this process being somewhat tedious for those stations indicated as holding a CP in that some stations have authority to broadcast under a CP while others do not. Reference had to be made to manually kept lists of such broadcast authorizations at the FCC to clarify this matter.

Another problem in the original files was that the aural carrier power for television stations is not kept in the TV engineering data base and in this instance, aural carrier power data was extracted from the Master File to enhance the TV engineering data base. A similar problem existed with the AM engineering data base in that it is not yet complete for all AM radio stations. Again use of the Master File provided the necessary information. After our careful preparation of a single consistent data base we found that the indicated number of broadcast stations actually on-the-air as of December 1, 1977, was 9387. These were partitioned by class as follows:

<u>Type of Station</u>	<u>Number on-the-air</u>
AM Standard Broadcast	4574
FM Radio	3829
TV VHF and UHF	984

For each station our edited data base contains the station call sign, frequency, latitude and longitude, power (both horizontal and vertical polarization components for FM and both visual and aural for TV), the city and state in which the station is located, and the height above average terrain (HAAT) for FM and TV stations.

A medical care facilities data base was obtained from the Federal Preparedness Agency¹⁰. This computer accessible file contains information on 7364 medical care facilities throughout the US. To our knowledge

this represents slightly more than all such facilities recognized by the American Hospital Association (AHA) as of January 1975. The AHA Guide to the Health Care Field¹¹ indicates that there were 7082 health care facilities in the US as of January 1, 1977. The data base contains extensive information on each facility, including for example, the pertinent city/state, the facility name, the latitude and longitude, the rated total bed capacity, average daily patient census, personnel figures, type of services provided, and a location accuracy code. This code, generated by the FPA, describes the supposed accuracy of the indicated coordinates for the facility. For the 7364 facilities in the total data base we analyzed the location accuracy codes and found that there were 2271 facilities, or 31 percent, which were classified as having the highest accuracy, this being stated by FPA as being within 200 meters of the indicated coordinates. Table 1 provides a breakdown of this analysis. For the purpose of this analysis we elected to use only those facilities which had the most accurately specified coordinates. This was done in the interest of obtaining the most accurate results for identification of extremely close proximity situations.

TABLE 1. ANALYSIS OF 7364 HEALTH CARE FACILITY LOCATION ACCURACY CODES

Accuracy Code	Description	No. in Class	Percent in Class
1	0-200 m	2271	30.8
2	200-500 m	1666	22.6
3	500-1500 m	1196	16.2
4	SLA*	36	0.5
5	Zip Code**	2195	29.8

*SLA=standard location area, coordinates in this class are for the nominal center of the SLA

**Coordinates for this class were for the post office serving the zip code of the given facility

After examining the types of services provided by each facility we took the liberty of further deleting certain facilities from consideration in the analysis. Table 2 shows the various types of services and those which we chose to delete because of the lower probability of significant use of critical life support instrumentation and/or equipment. After deletion of those facilities with particular services we obtained a final computing data base of 2000 facilities which met our requirement of having the best determined coordinates and also most likely to make use of critical equipment. It is our estimation that this number represents about 27 percent of all health care facilities in the US recognized by the AHA.

Method of Analysis

Our procedure of analysis consisted simply of the following: for each of the 2000 hospital facilities used in the study, a computation of the distance to each AM, FM, and TV station in our broadcast data base was made. For each class of station, the station found to be the closest to the hospital was noted as was its distance and power. In the case of FM and TV stations we also retained the HAAT. Additionally we kept record of all stations of each class and their summed power within one mile of the hospital. This

particular data was retained because it was felt that such information could form an index of the nearby disposition of multiple transmitter sites.

TABLE 2. HEALTH CARE FACILITY SERVICE TYPE AND INCLUSION OR DELETION FROM ANALYSIS

Type of Service	Included in Analysis	Deleted from Analysis
General medical and surgical	X	
Hospital unit of an institution	X	
Armed forces dispensary		X
Psychiatric		X
Tuberculosis and other respiratory diseases	X	
Narcotic addiction		X
Maternity	X	
Eye, ear, nose, and throat		X
Rehabilitation		X
Orthopedic	X	
Chronic disease		X
Other speciality	X	
Alcoholism		X
Childrens general	X	
Childrens hospital unit of institution	X	
Childrens psychiatric		X
Childrens TB and other respiratory diseases	X	
Childrens eye, ear, nose, and throat		X
Childrens rehabilitation		X
Childrens orthopedic	X	
Childrens other speciality	X	
Osteopathic hospital	X	
Childrens chronic diseases		X

Results

For each class of station the accumulative percentage of hospitals with minimum separation distances ($d_{\min}$) to the nearest broadcast station were plotted as a function of separation distance in Figures 1, 2, and 3. The data are plotted on log-probability paper and visual best fit curves were drawn through the data points. It is interesting to observe the apparent log normal behavior of the fraction of hospitals with $d_{\min}$ values $\leq$ the indicated separation distances. Because we have not yet tested the data rigorously, we can not specify a confidence level at which the data is log normally distributed but there is every indication that the data is so distributed at least for AM and FM stations. From the results presented in Figures 1, 2, and 3 we have summarized several pertinent observations in Table 3. For each class of station Table 3 provides the $d_{\min}$ values associated with 1, 50 (the median), and 90 percent of the hospitals as well as the percentage of hospitals with $d_{\min}$ values $\leq$ 1 mile.

It can be seen that 19 percent of the hospitals analyzed are within 1 mile of at least 1 AM station, 20 percent are within 1 mile of at least 1 FM station, and 2.7 percent are within 1 mile of at least 1 TV station. Also, 1 percent of the hospitals studied were found to be within 0.18 miles of an FM station.

Figure 1. Hospital Proximity to AM Broadcast Stations

Figure 3. Hospital Proximity to TV Broadcast Stations

Figure 2. Hospital Proximity to FM Broadcast Stations

TABLE 3. SUMMARY OF PERTINENT OBSERVATIONS FROM FIGURES 1, 2, AND 3

Class of Station	Separation distance (mi) for various accumulative percentages of hospitals			Percent hospitals with $d_{\min} \leq 1$ mile
	1%	50%	90%	
AM	0.25	2.29	7.59	19
FM	0.18	2.51	11.22	20
TV	0.56	10.00	35.48	2.7

Table 4 summarizes the results of analyzing the total effective radiated power (ERP) of all stations identified as being within 1 mile of each class of station. It is interesting to note that 3 hospitals studied are located within 1 mile of a total accumulative ERP of TV stations of between 10 and 100 MW.

TABLE 4. NUMBER OF HOSPITALS WITH VARIOUS
TOTAL ERP WITHIN 1 MILE

Total ERP of stations within 1 mile (kW)		No. of hospitals with total ERP within 1 mile		
		AM	FM	TV
10000	- 100000	-	-	3
1000	- 10000	-	1	13
100	- 1000	-	102	44
10	- 100	9	110	6
1	- 10	226	86	-
.1	- 1	17	19	-
.01	- .1	-	80	-
	<.01	1748	1602	1934
TOTAL		2000	2000	2000

Note: There are 6 hospitals with a 50 kW AM station within 1 mile

Table 5 is provided to illustrate the type of computer data output obtained in this study. This table comprises a list of hospitals, ordered by increasing $d_{\min}$ values for the first 60 hospitals having smallest $d_{\min}$ values. Each line of Table 5 contains a sequence of data which may be decoded by referring to the notes found in the following chart:

Date Field	Description
1	Sequence Code
2	Hospital Name
3	City
4	State
5	Type of Service Code
6	Government or Non-Government Code
7	Length of Stay Code
8	Total Number of Beds
9	Daily Patient Census
10	Total Personnel (Full Plus Part Time)
11	Station Class Code (1=AM, 2=TV, 3=FM)
12	Call Sign of Closest Station
13	Minimum Separation Distance (Miles)
14	Frequency (MHz) (MHz)
15	Total ERP of Closest Station
16	HAAT of Closest Station
17	Number of Stations of Same Class Within 1 Mile
18	Total ERP of Stations Within 1 Mile

In view of the associated accuracy of the hospital coordinates used in this study it is not possible to assign an absolutely proper order to the indicated hospitals with distances shown less than 0.12 miles. Thus if one were to individually check each hospital by actually measuring the distance between it and the nearby station, a reordering of the indicated $d_{\min}$ values might occur. Also we caution that there is always the possibility of inherent error in each data base used in that despite our careful attention to insure accuracy, a hospital may no longer be at the indicated location or that a station may have erroneously indicated coordinates. We believe, though, that the results can be interpreted certainly as representative of the hospital-station proximity relationship.

Summary

A method of identifying hospital sites with the potential for high intensity radiofrequency fields has been described. Two data bases consisting of both AM, FM, and TV broadcast stations and medical care facilities in the US were prepared for a subsequent computer examination of the minimum separation distances between each hospital and the nearest broadcast station. Using a subset of the health care facility data base of some 2000 hospitals and a broadcast station inventory of 9387 stations it was found that 18 percent of all hospitals are located within 1 mile of an AM station, 20 percent within a mile of an FM station and 2.7 percent within a mile of a TV station. It is interesting to note that these figures can be taken as representative for AM and FM stations at the 1500 meter (.93 mile) distance suggested by FDA⁹ as being a reasonably probable separation distance for hospitals. The closest indicated separation distance for the hospitals studied was 0.02 miles and this was confirmed by contact with the hospital's administration. The median separation distances, i.e., those distances within which a station is located for half of all hospitals, were found to be 2.29, 2.51, and 10.0 miles for AM, FM, and TV stations respectively. Data are presented which allow determination of the accumulative fraction of hospitals having minimum separation distance $\leq$ than various values. A table is provided which illustrates, for those hospitals determined to be closest to stations, the closest found station, its type, power, and antenna height (if FM or TV), and administrative data specific to the hospital.

TABLE 5. ILLUSTRATIVE COMPUTER OUTPUT; ORDERED BY ASCENDING $D_{\min}$ (DATA FIELD 13)

WEST PALM BEACH		0.02107.9	200.000	340	2	400.000
110001	GOOD SAMARITAN HOSPITAL	FL1023110003040002270008363WIRK				
110002	CANDLER GENERAL HOSPITAL	GA102110003240002670009853WTC	0.07 94.1	97.500	370	2
110003	FERGUSON-DROSTIE-FERGUSON HOSP	MA102310001100000860002813WLAU	0.09 96.9	56.000	180	1
110004	ART CENTRE HOSPITAL	MI102310001570001410004263WDET	0.1101.9	158.000	450	4
110005	MERCY HOSPITAL	ME102110001800001180006363WLOB	0.12100.9	6.000	225	1
110006	SILVER CROSS HOSPITAL	IL102310003670002890010783WLLI	0.12 96.7	6.000	300	1
110007	IDMA METHODIST HOSPITAL	IA102310007420006170017853KRNG	0.1302.5	200.000	510	3
110008	VETERANS ADMINISTRATION HOSP	FA104510004750004010010263WPN	0.14 88.9	3.800	280	1
110009	WILLIAM BOOTH MEM HOSPITAL	MA142110000110000010000113WJRF	0.14 96.3	100.000	480	3
110010	ST MARY'S HOSPITAL	IL102110001340009000003633WVKC	0.15 90.5	0.010	0	1
110011	PROVIDENCE HOSPITAL	SC102110001730001240005083WXYR	0.15 93.5	3.400	380	3
110012	SPENCER HOSPITAL	FA102310001610001170004043WARC	0.16 90.3	0.033	79	1
110013	CHARITY HOSPITAL OF LOUISIANA	LA102110016420013750054583WEZB	0.16 97.1	186.000	450	4
110014	VETERANS ADMINISTRATION HOSP	CA104510006590004100018673KIT	0.16105.3	151.000	180	1
110015	CHILDREN'S HOSPITAL	MD572310001240000850002573WMAR	0.17106.5	58.000	620	4
110016	CENTER CITY HOSPITAL	FA103210000590000510001113WFWT	0.17 91.7	0.180	10	3
110017	ST JOSEPH'S HOSPITAL	FA472120001460001180001463WVMW	0.18 91.5	0.010	0	1
110018	CLINTON CNTY WAR MEMORIAL HOSP	KY101310000420000170000553WANY	0.19106.3	2.700	155	1
110019	ST FRANCIS HOSPITAL	LA102310003340002330008253KREB	0.19106.1	30.000	190	1
110020	ST MARY'S MEMORIAL HOSPITAL	TN102110004650004530013233WKC5	0.19 91.1	0.310	73	1
110021	BROOKLYN HOSPITAL	NY10231000440003970016703WNYE	0.19 91.5	20.000	430	1
110022	SAINT MICHAEL'S MEDICAL CENTER	NJ102110004280003770012303WBG0	0.19 88.3	20.000	220	1
110023	VIRGINIA MUNICIPAL HOSPITAL	MA101410002950001150004433WIRN	0.19107.1	3.000	105	1
110024	SOLDIERS' HOME IN HOLYOKE	MA491220002320001960003083WCKH	0.19 89.5	0.010	0	1
110025	FORDHAM HOSPITAL	NY101410004060002790016603WUFU	0.20 90.7	100.000	215	1
110026	ROSWELL PARK MEM INSTITUTE	NY491210003190002550015843WBLK	0.20 93.7	50.000	400	3
110027	NASHVILLE METRO GEN HOSPITAL	TN10151000200001230007533WKDF	0.20103.3	200.000	390	2
110028	NAVAL HOSPITAL	FL10431000900000460002923WFFN	0.20 92.5	48.500	135	1
110029	FRANKLIN MEM HOSP BROKEN ARROW	OK1023100025000140000523KNG0	0.20 92.1	6.000	245	1
110030	SHRINERS CHILDREN'S HOSPITAL	MN57232000400000250000903KEEY	0.20102.1	200.000	360	2
110031	ST JOSEPH'S INFIRMARY	GA102110001820001520001973WZGC	0.21 92.9	200.000	590	1
110032	WESSON MEMORIAL HOSPITAL	MA102310003640002890011423WTC	0.21 90.7	8.000	92	1
110033	WEST PARK COUNTY HOSPITAL	WY10161000420000180000893KYDZ	0.21 90.1	0.010	0	1
110034	TRINITY LUTHERAN HOSPITAL	MO102110003050002230008043KCEZ	0.21 94.9	194.000	1060	2
110035	NIX MEMORIAL HOSPITAL	TX10331000190001590005003WDAI	0.21 97.3	170.000	450	5
110036	PROFESSIONAL CENTER HOSPITAL	AL10331000066000440001383WFI	0.22 98.9	17.500	135	1
110037	HERMANN HOSPITAL	TX102310005050004680024343KTRU	0.22 91.7	0.340	155	2
110038	MERCY HOSPITAL	IA102110002480001720006503KSUI	0.22 91.7	17.500	90	1
110039	LE ROY HOSPITAL	NY10231000080000770001973WHBI	0.23105.9	20.000	390	4
110040	METROPOLITAN HOSPITALS	MI102310002170001540011263WDR	0.24 90.9	17.000	175	1
110041	THOMAS JEFFERSON UNIV HOSPITAL	FA1023100066400052600299183WMMR	0.24 93.3	50.000	670	3
110042	GRAD HOSP OF THE UNIV OF PENN	FA10231000297000251000933WFWT	0.24 91.7	0.180	10	3
110043	VANDERBILT UNIVERSITY HOSPITAL	TN102310005030004510018203WURV	0.24 91.1	0.430	150	1
110044	CHILDREN'S HOSPITAL OF PHILA	PA50231000238000120009853WFWT	0.25 91.7	0.180	10	3
110045	ST JOSEPH HOSPITAL	MI10211000423000320013403WFB	0.25 95.1	3.700	115	1
110046	CHILDREN'S HOSPITAL	OH502310003010002810015063WFFAC	0.25 91.5	0.010	0	1
110047	ST JOSEPH HOSPITAL	CT102110002720001710006453WYRS	0.25 96.7	3.000	280	1
110048	BETHESDA GENERAL HOSPITAL	MD102310001300000580002763KSLH	0.25 91.5	12.500	400	1
110049	ST LOUIS UNIVERSITY HOSPITALS	MO102110003190002360008163KSLH	0.25 91.5	12.500	400	1
110050	GEN HOSPITAL OF MONROE COUNTY	FA102310002250001840006183WESS	0.26 90.3	0.010	0	1
110051	VETERANS ADMINISTRATION HOSP	LA104510005810005020012583WEZB	0.26 97.1	186.000	450	4
110052	SCHUMPERT MEMORIAL HOSPITAL	LA102110003740003420009553KMBQ	0.27 93.7	200.000	265	2
110053	ARLINGTON HOSPITAL	VA10231000325000254001973WETA	0.27 90.9	120.000	610	2
110054	VETERANS ADMINISTRATION CENTER	VA104510004420004020010843WHOV	0.27 88.3	0.010	0	1
110055	HENRIETTA EGGLESTON HOSPITAL	GA502310001000000530003753WSEB	0.27 98.5	200.000	740	1
110056	VA RESEARCH HOSPITAL	IL104510005330003990012913WMET	0.27 95.5	12.000	1170	12
110057	BURNHAM CITY HOSPITAL	IL101410001840001760007303WPGU	0.28107.1	2.950	235	2
110058	CHILDREN'S HOSP OF PITTSBURGH	PA502310002250001680010163WQED	0.29 89.3	86.000	500	3
110059	PRESBYTERIAN-UNIVERSITY HOSP	PA1023100050460005010022833WQED	0.29 89.3	86.000	500	3
110060	AKRON CITY HOSPITAL	OH10231000641000637002193WJUP	0.29 88.1	6.000	115	2
1		4 5 6 7 8 9 10 11 12 13 14 15 16 17 18				

References

1. Tell, R.A., "Environmental Nonionizing Radiation Exposure: A Preliminary Analysis of the Problem and Continuing Work Within the Environmental Protection Agency," Presented at the Session on Environmental Exposure to Nonionizing Radiation at the Annual American Public Health Association Meeting, November 14, 1972, Atlantic City, NJ, Session Proceedings, (EPA/ORP 73-2) U.S. Environmental Protection Agency, Washington, DC, May 1973 [NTIS Order No. PB 220 851] .
2. Rowe, W.D., D.E. Janes, and R.A. Tell, "An Assessment of Adverse Health Effects of Telecommunications Technology," 1973 National Telecommunications Conference, November 26-28, 1973, Atlanta, GA.
3. Hankin, N.N., R.A. Tell, and D.E. Janes, "Assessing the Potential for Exposure to Hazardous Levels of Microwave Radiation from High Power Sources," Health Physics Society Annual Meeting, Houston, TX, July 1974, Abstract, Health Physics 27:633, December 1974.
4. Tell, R.A. and D.E. Janes, "Broadcast Radiation: A Second Look," U.S. National Committee, International Radio Science Union Annual Meeting, Boulder, CO, October 20-23, 1975, Abstract, Program and Abstracts, pp 312-313, USNC-URSI, National Academy of Sciences, Washington, DC, 1975. Biological Effects of Electromagnetic Waves, Selected Papers of the USNC/URSI (1975) Annual Meeting, Vol. II, pp 363-388, C.C. Johnson and M.L. Shore, eds., Publication (RDA) 77-8010, U.S. Department of Health Education and Welfare, Rockville, MD December 1976.
5. Ruggera, P.S., "Changes in Radiofrequency E-Field Strengths Within a Hospital During a 16-Month Period," U.S. Department of Health, Education, and Welfare PHS; FDA: DHEW Publication (RDA) 75-8032.
6. Frank, V.A., and R.T. Londner, "The Hospital Electromagnetic Interference Environment," J. Assn. for Advancement of Medical Instrumentation, Vol. 5, No. 4, pp 246-254, July, August 1971.
7. Vreeland, R.W., M.D. Sheperd, and J.C. Hutchinson, "The Effects of FM and TV Broadcast Stations Upon Cardiac Pacemakers," presented at 1974 IEEE EMC Symposium, Publication No. IEEE 74CH0803-7 EMC.
8. Tell, R.A., J.C. Nelson, and D.A. Janes, "An Observation of Radiofrequency Interference to an Electronic Thermometer," U.S. EPA internal report, March 1975.
9. FDA, "EMC Standard for Medical Devices-Final Report," prepared by McDonnell Douglas Astronautics Company-East for Department of Health, Education, and Welfare, Food and Drug Administration, Bureau of Medical Devices, Report MDC E1609, 20 December 1976.
10. FPA, "Resource Data Catalog," General Services Administration, Federal Preparedness Agency publication, GSA/FPA/MCL TM-258, February 1976.
11. AHA, "American Hospital Association Guide to the Health Care Field," published by the American Hospital Association, Chicago, IL, 1977.