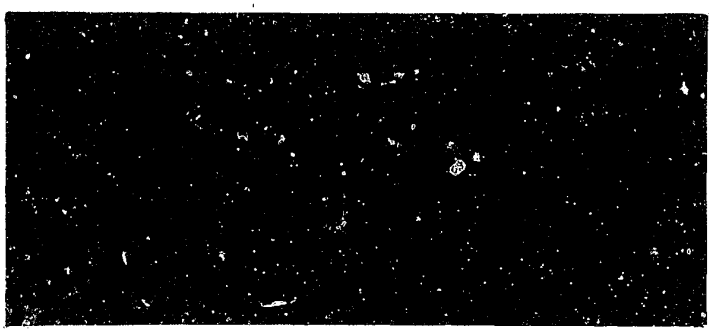
EVALUATION REPORT



The Florida Department of Administration Division of State Planning

• BUREAU OF CRIMINAL JUSTICE • PLANNING & ASSISTANCE

DSP-BCJ-4-78

EVALUATION REPORT

Statewide Law Enforcement Communications

Division of Communications

APRIL 1978

FOREWORD

Hundreds of millions of local, state and federal dollars are expended annually to operate and improve the criminal justice process in Florida. Historically, few assessments have been conducted to judge the need or usefulness to the criminal justice process of its related operations.

The citizens of this state have relied upon the integrity and professional knowledge of its lawmakers and system administrators to annually judge the continued need for a project's operation. Project managers and supervisors, responsible for the ultimate products of an operation and intensively involved in daily operations, have so much personal effort and professional pride at stake few can objectively assess operational effectiveness.

The following report is an attempt to objectively assess the operations and needs for one state-level project. It is hoped that the report's findings and recommendations will be more than a "paper weight for recyclable materials", but will be used by responsible decisionmakers when asking the question - "Is the system's need and project's results worthy of taxpayer support"?

- Nick Collins
Project Evaluator

SUMMARY

STATEWIDE LAW ENFORCEMENT COMMUNICATIONS

Florida Division of Communications

INTRODUCTION

There are approximately 400 local law enforcement agencies in the State of Florida, which, without exception, require communication capabilities to provide basic levels of law enforcement and community services. Historically, the development of communications systems in the state were hampered by a lack of documented system needs, irrationally and non-systematic planned local system configurations and the lack of non-partisan technical expertise to develop and guide the implementation of a total law enforcement communications network for the state.

The predominant need during the late 1960's was for guidance to be provided to all users of communications systems. The need was addressed by Florida's 1969 and 1972 Legislature which created the foundation at the state level for technical engineering services and directed the creation of a planned strategy for all future law enforcement communication systems. The Division of Communications (DIV-COM) was created and charged with planning, developing and directing the implementation of a statewide law enforcement communications system.

FINDINGS

As a result of communications needs and directive legislation, the Div-Com has been continually supported with federal resources for six and one-half years from eight separate fiscal funding periods. A total of $703,119 in federal/state resources have been expended to support the legislation and meet the needs of the state in developing and guiding the implementation of law enforcement communications systems.

The Div-Com project, "Statewide Law Enforcement Communications", was assessed from a technical assistance delivery standpoint and depended upon project staff input, law enforcement agency questionnaire responses and the analysis of project and SPA files.

The analysis of data points to several conclusions. The Division's Public Safety Section is providing the law enforcement community in the state with significant levels of quality service. The section's communications engineers are responsive to the requests and inquiries of all agencies geographically and by size. The level of satisfaction expressed by the agencies for services provided is a good indicator of the professional and technical capabilities of the engineers. On the basis of questionnaire response, the analysis indicates that at least one-half of all agencies are unaware of the Division of Communication's legal mandates and authority. Even though law enforcement agencies indicate that they are not fully informed as to the types of technical assistance services available to them, the Division of Communications' files indicate that with few exceptions, all agencies have been provided some type of technical assistance during the last four years of the project.

Finally, most agencies do not feel that their communications needs have been thoroughly assessed. To strengthen the existing technical assistance approach, the following recommendations are made to be incorporated into the Div-Com project.

RECOMMENDATIONS

1. The statewide law enforcement communications project, as a component of the Division of Communications' services, should be continued with the use of state general revenue funds.

2. The Statewide Law Enforcement Communications Master Plan should be revised to incorporate a systems needs analysis and a system's priority implementation process.

3. The Division of Communications should develop and implement standardized equipment and system engineering specifications, to be revised periodically.

4. The Division of Communications should develop and publish an information pamphlet for distribution to all law enforcement agencies stating the Division's statutory authority and responsibility, types of services available to agencies and general requirements of the State Master Plan.

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I. INTRODUCTION

The consideration of criteria for the selection of a state level, federally-funded project involved the review of past state comprehensive plans for the improvement of the criminal justice system. Prime consideration was given to the 1975, 1976 and 1977 state plans with a review of each plan's problem analysis and multi-year objectives. A thorough analysis pointed to particular criteria for final selection of a project to be evaluated by the Bureau of Criminal Justice Planning and Assistance's (BCJPA) Planning and Evaluation (P & E) Section.

Selection criteria included:

- Problem being addressed. The identification of problems and multi-year objectives for problem solution in several state comprehensive plans.

- Project continuance. The continuation of a project for an extended length of time (three or more years) as defined in state comprehensive plans.

- Fund allocation. The consideration of the amount of federal and state revenues being appropriated to support an individual project effort.

- Multi-year needs. The continued identification of a single need as identified in several comprehensive plans.

- Law enforcement component impact. The consideration of what impact or result a single project may be having on the law enforcement community.

- Legal mandates. Legislative requirements for service to be provided by the state to local units of governments.

Based upon the before-mentioned factors, the "Statewide Law Enforcement Communications" project implemented by the Division of Communications (Div-Com), Department of General Services, was chosen.

Since early 1970, in each of Florida's Annual Comprehensive Criminal Justice Plans (1970-1978), the problem of inadequate communication systems in state and local law enforcement agencies has been identified and well-documented. The projection of a single need has also reoccurred from year to year. A centralized communications engineering and planning capability was needed to determine and develop system needs, develop equipment specifications and to consult with local and state agencies.

Possibly the most significant selection criteria dealt with length of project continuation and total funds appropriated. The Div-Com project was initiated in 1970 and has been continually funded through the 1977 fiscal year with over $694,000 in federal funds and $77,000 in state matching funds.

Finally, the project's impact appeared to be considerable since, on the basis of 1969 Florida legislation, Div-Com was established for the purpose of planning and coordinating all telecommunications services in the state. The project is the prime determinant for planning and approving the implementation of communications systems in all law enforcement agencies in the state.

The Div-Com project evaluation is intended to be reviewed and considered by more than the staff and administration of the BCJPA. The report's findings and recommendations contain significant indicators as to the project's impact in achieving the grant's objectives and, therefore, its success as a technical assistance concept. The results will indicate to the BCJPA and LEAA whether or not federal and state resources have significantly benefited the state and its criminal justice system.

The Division of Communications should use the results as a self assessment/management tool in analyzing current policies, procedures, scope of services and emphasis in the delivery of technical assistance services to the law enforcement community.

Finally, the 1978 Florida legislature, the Governor and the Bureau of Budget should analyze the evaluation's findings and use them in a final decision of whether or not to continue law enforcement communications technical assistance engineering services with state general revenue funds.

II. METHODOLOGY

Evaluation Objectives - Evaluation report objectives were identified and specified in an initial design to clearly indicate the assessment's scope and methodology. The report's objectives include:

Report Objective #1 - Conduct a historical analysis of LEAA-funded efforts within the Division of Communications. Include expenditures per period, accomplishments per period and a general cost analysis.

Report Objective #2 - Determine the efficiency of the project meeting the measurable objectives as set forth in the project's 1976 LEAA grant.

Report Objective #3 - Determine the usefulness of the Statewide Communications Plan in assessing resources and determining needs within law enforcement agencies in Florida.

Report Objective #4 - Determine local law enforcement agencies perception of the assistance provided by the Division of Communications efforts.

Report Objective #5 - Determine the qualifications of project staff in providing specialized communications assistance to local agencies.

To fulfill each objective of the design, specific measurements were identified and applied procedurally during the project's assessment.

Report Objective #1 - The historical analysis relied on information provided in grant project files and by project staff. The major accomplishments for each funding period were categorized into general staff activities. A percentage estimate was provided by project personnel or project records to indicate the amount of time it took to accomplish the categorized activities. An estimated cost was developed and a general cost analysis made.

Report Objective #2 - Data was obtained from project quarterly reports and from other project records. A technical assistance questionnaire was mailed to 386 law enforcement agencies to gather additional data/information in judging project objectives. A comparison of actual accomplishments was made with intended accomplishments and an analysis made of any discrepancies.

Report Objective #3 - Information was gathered to identify how the statewide Law Enforcement Communications Plan has been developed, evaluated by Div-Com and revised to incorporate needed changes since its adoption. An additional assessment was made to determine the need for additional changes and incorporate more specific recommendations.

Report Objective #4 - The same sample of law enforcement agencies used to measure objective 2 was used to provide information for this objective. A technical assistance questionnaire was used to determine the number and type of contacts between the agency and the Division of Communications, the amount and type of technical assistance provided to the agency, and subjective appraisal of the quality of services provided to the agencies by the Division of Communications.

Report Objective #5 - The qualifications of present project personnel was determined by reviewing their personnel records. Particular emphasis was placed on documenting the type and length of the project personnel's past occupational and training experience in the communications and engineering areas. Any specialized training or staff development activities in which project personnel have participated were noted.

Report Assessment Limitations - The development of an initial evaluation design included seven major assessment objectives to be achieved in conducting the evaluation of the project. Based upon estimates of the Bureau's Evaluation Coordinator, an average of six man-weeks would have been required to completely assess all aspects of the project as defined in the original evaluation design. Because of additional workload priorities of the Bureau's Planning and Evaluation Unit, less than three man-weeks could be devoted to the evaluation. This is not to suggest that an adequate assessment was not conducted relative to the five evaluation objectives previously presented. The time factor limited the types of data that could be gathered during the period and, thus, forced a narrowing of the evaluation's scope. Specifically, the following report objectives were not incorporated in the evaluation effort.

Report Objective #6 - Conduct a manpower workload study to determine the average workload of project staff.

Report Objective #7 - Determine the impact of this project on improving communications equipment and providing quality technical assistance services to local enforcement agencies.

Report Objective #8 - Make recommendations concerning whether the project should be continued at reduced, equal or an increased level.

DATA ANALYSIS

Comparative data varied from objective to objective. In a number of objectives, the stated objectives of the project were compared with the actual accomplishments of the project. In other objectives, the actual operation of the project was compared with formal guidelines and standards. Generally accepted principles of effective management/administrtation were used to evaluate the actual management and administrative structure of the project. Some objectives would have required time-series analysis to determine the type and extent of project-related change over time. As a general policy, no conclusive statement was rendered unless such a conclusion could be corroborated by two independent data sources.

Distribution of Report/Implementation Strategy - The draft evaluation report was reviewed by project personnel prior to finalizing. Any errors that were documented and verified in the draft report were corrected or omitted prior to final release. Copies of this report were provided to the Division of Communications project personnel, members of the Police Task Force, staff of the BCJPA and any other interested party.

Recommendations made in this report will be incorporated into an implementation timetable. This timetable will specify the date by which the evaluation recommendations should be implemented. Monitoring personnel from the Bureau of Criminal Justice Planning and Assistance will be responsible for assuring that the timetable for implementation is followed.

III. BACKGROUND DATA

The Division of Communications was created by the 1969 Florida Legislature which recognized a need for more effective State Telecommunications Systems. The powers and duties of Div-Com were set forth in Section 287.25, Florida Statutes. Of the 19 provisions of the Act, several have a direct interest to the law enforcement community and apply specifically to the "Statewide Law Enforcement Communications" project. These include:

1. The development of a statewide plan for telecommunication services for all state agencies;

2. The provision of aid to state government agencies and political subdivisions in the state with respect to the "organizing of communications systems";

3. The provision of advice to state government agencies and political subdivisions of the state as to systems or methods to be used to meet communications requirements efficiently and effectively; and

4. The application for and acceptance of federal funds for any of the purposes of the Act, as well as gifts and donations from individuals, foundations and private organizations.

Subsequent legislation passed in 1972, Section 287.29, Laws of Florida, firmly laid the legal foundation for the development of a statewide system of regional law enforcement communications. It was the intent and purpose of the legislature that a statewide system be developed in order for law enforcement agencies to deal more effectively with the apprehension of criminals and the prevention of crime. The following depicts the provisional requirement of the law:

1. All law enforcement entities were directed to furnish Div-Com with any information requested;

2. Div-Com was authorized and directed to develop a statewide communications system by dividing the state into regions and developing:

   - requirements for each county and municipality;
   - interagency communication interfaces between municipal, county and state law enforcement entities in the region.
   - an organizational layout provision to include each law enforcement entity and the number of radio operating units, fixed, mobiles and hand held, per entity;
   - frequency allocations and use provision to include per entity it's operation and type of operation;
   - operating provisions incorporating operational procedures for local, regional and an emergency basis.
   - a law enforcement agency telephone provision.

3. Div-Com was directed to develop, by June 1, 1973, a Statewide Communications Plan and to implement and coordinate the plan with necessary rules and regulations.

4. Div-Com was provided total prior approval authority for the establishment and expansion of all communications projects after July 1, 1972.

The present organizational structure of the Division of Communications is pictured in Chart 1 and 2. Since its origination in 1969, the Division has gone through several organizational changes which were primarily due to its growth and legislative requirements, in addition to those previously mentioned. (Florida Emergency Telephone Act, Florida Emergency Medical Services Act of 1973).

Of the two bureaus in Div-Com (Bureau of Telephone Communications and Bureau of Communications Engineering) only the latter will be discussed since it is here that the project is organizationally and conceptually related.

CHART I

DEPARTMENT OF GENERAL SERVICES

DIVISION OF COMMUNICATIONS

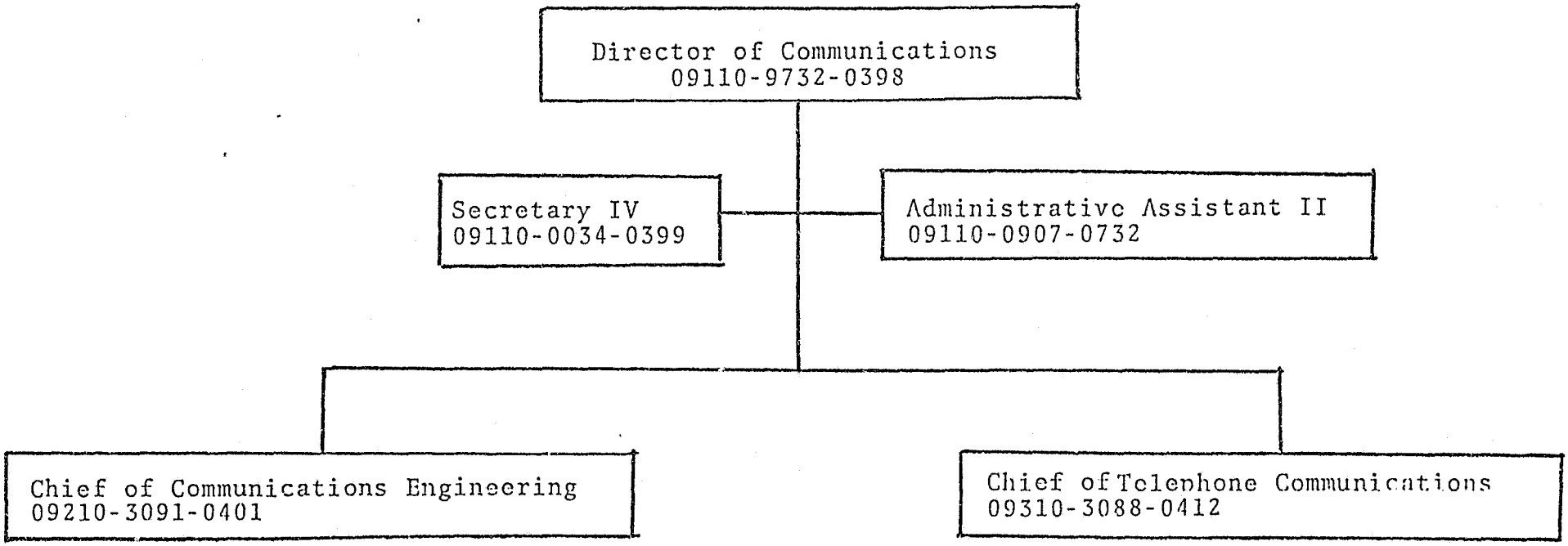
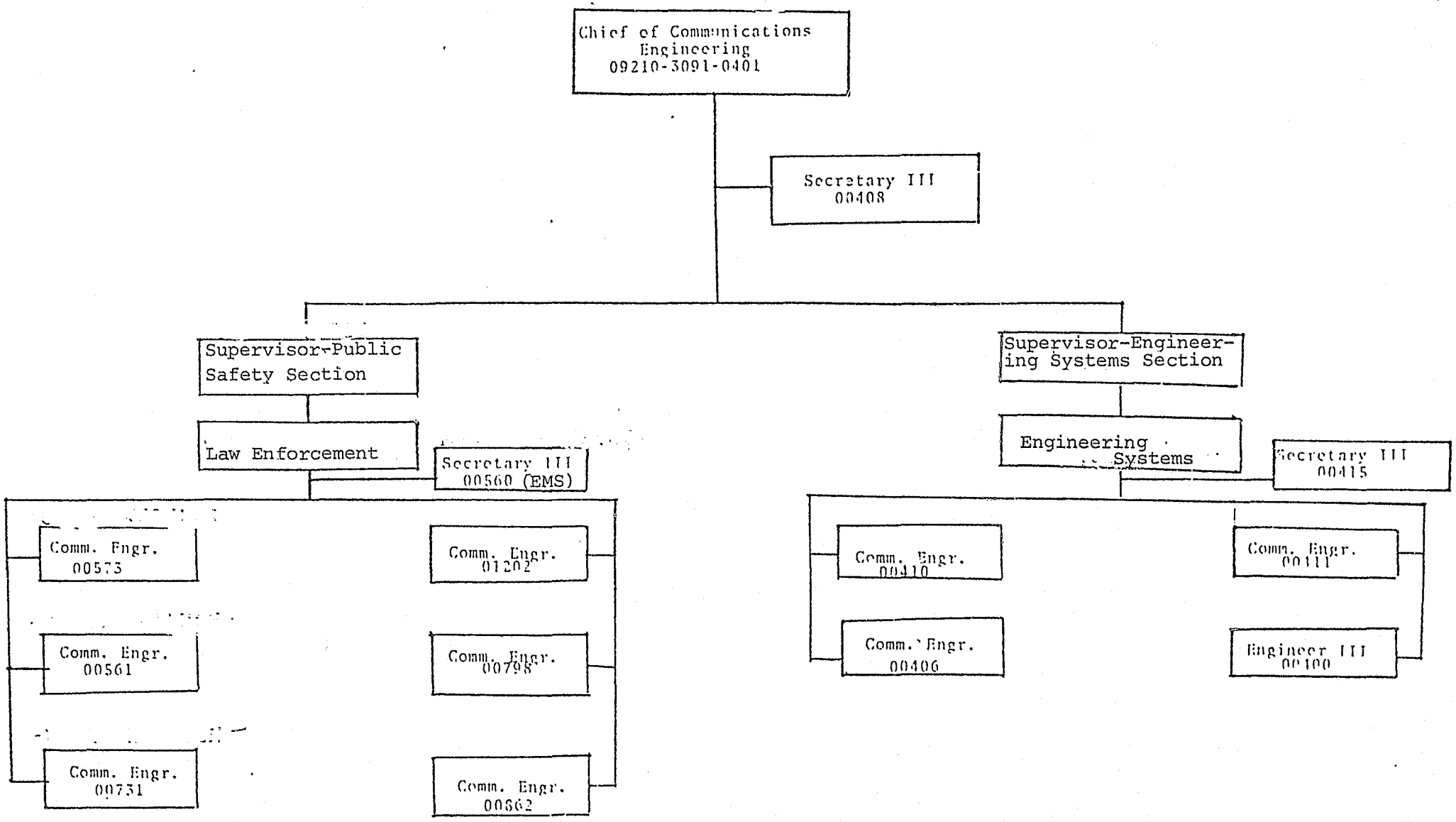


CHART II

DEPARTMENT OF GENERAL SERVICES

DIVISION OF COMMUNICATIONS

BUREAU OF COMMUNICATIONS ENGINEERING



The Bureau of Communications Engineering has 16 personnel (three in management, three secretaries and 10 communication engineers). The Bureau is further divided into an "Engineering Systems Section" and "Public Safety Section". The entire Bureau has primary responsibility over radio frequency (RF) communication systems at the state and local level which are regulated or controlled by state and/or federal legislation/regulations. The Engineering Systems Section is assigned the responsibility of assisting and regulating state agency systems. The Public Safety Section is responsible for local jurisdiction systems in the law enforcement communications systems.

The Public Safety Section of Div-Com (Chart 2) has six communications engineers, one secretary and a section supervisor. Three of the engineers have responsibility for implementing responsibility of Section 287.29, Laws of Florida (see page 7 - Law Enforcement Communication). The FY '73 through '77 grants have furnished salary support for two of the communications engineers and one secretary as well as other law enforcement communications activities performed by the Public Safety Section.

The Statewide Law Enforcement Communications project was initiated in November, 1970, with the award of $120,737 in federal funds. The project has since continued with the awarding of seven additional federal grants for a total (federal and state monies) of $703,119 during the six and one-half year period. The total federal/state funding ratio is 65/35 percent.

The FY '70, '71 and '72 grants focused on the development of a telecommunications plan and the provision of guidance to state agencies and local units of government in the development of more efficient and effective systems. The FY '70 and '71 projects consisted of two phases: the completion of engineering surveys and studies and the development of a preliminary systems concept study. Phase I utilized two division engineers (100% federally funded), twelve division personnel (state match for the project) and the services of a consultant to conduct surveys of local and state criminal justice system agencies. The primary intent and result of Phase I was the evaluation of the state's telephone usage systems, a detailed analysis of the microwave transmission system on the Florida Turnpike and other microwave systems of the state and studies of local communications facilities and operations.

Phase II intensified the efforts of Phase I by utilizing information gathered during the first project period & by contracting with 2 additional consulting firms. The two contractors and two full-time engineers of Div-Com were to perform an in-depth investigation of telephone switching and trunking techniques in view of application, availability, and cost comparison, to determine the most optimum statewide telecommunications system from the engineering survey and study data, to determine initial cost of a statewide telecommunications system designed to carry voice, data and television intelligence, and to obtain information on factors which must be considered when implementing a statewide telecommunications system (FCC rules, available hardware, availability of technical personnel, and funding sources). Finally, expected cost for the maintenance and operation of a statewide system were to be projected.

The FY '72 project grant brought resolution to the state's law enforcement communications program by emphasizing the development of a statewide Law Enforcement Communication Masterplan. The results of the consultant's studies during the previous funding periods, the completion of regional communication plans in the Florida panhandle and Miami-Dade areas and the requirements of the 1972 Florida Legislature for the completion of a plan by June, 1973, were influencing factors in the development of this Law Enforcement Plan. The FY '72 grant award supported a consultant contract for the development of this master plan. The Atlantic Research Corporation was selected and assigned to the Bureau of Communications Engineering. All Division staff were supported with state resources for the grant period.

The FY '73 grant project (Statewide Law Enforcement Communications) began the support of Div-Com activities to implement the Statewide Law Enforcement Communications Master Plan. The project's functions, as well as those of four subsequent grants for law enforcement engineering, have remained consistent in approach as noted by each project's objectives and activities. The project's objectives included:

1. The review of grants concerning law enforcement communications projects to assure compliance with the master plan;

2. The improvement of equipment reliability and serviceability by providing up-to-date equipment specifications;

3. The provision of system specifications to reduce inter- and intra-agency interference to an acceptable level and to improve intra-agency communications to an acceptable level (approximately 90%);

4. The provision of personal/portable system specifications;

5. The provision of audio logging recorder specifications; and

6. The provision of engineering support planning to local law enforcement agencies for the efficient and effective change to the master plan system.

The noteable exception was the use of $13,978 in the FY '73 grant for consultant fees. The Stanford Research Institute (SRI) was chosen in December, 1973, to study and select the most amenable concept for implementing a universal emergency telephone number, 911, on a statewide basis. Florida's Emergency Telephone Act was passed by the Legislature in 1974 to implement the results of the SRI study. The Act mandated to Div-Com the responsibility and authority to implement the system statewide by FY '78.

The development of a seven-part administrative agreement between the Division of Communications and the Bureau of Criminal Justice Planning and Assistance was initiated in July, 1974. The agreement formalized the grant review process between the agencies (objective 1) to assure compliance with Florida legislative requirements concerning communications systems. This agreement remains in effect between the agencies. (see appendix 1)

The significant problems addressed by the project since its initiation with federal funds can be categorized into two groups:

Problem Area #1 - A lack of documented systems' configurations and needs relative to those systems. Following the creation of Div-Com and preceeding the development of the Law Enforcement Master Plan, the law enforcement component of the criminal justice system had not taken advantage of technical advances made in the science and engineering community. For Florida, there had not been a uniform and coordinated approach to improving communication systems. As a result, local agencies were confronted with severe radio congestion problems which became more acute with the addition of more radios to the system. Local agencies were seeking to improve there communications with little or no guidelines as to how best to design and organize communications operations. In most areas, agencies were organizing into small independent networks resulting in inefficient use of available resources, frequency congestion and interference. The Federal Communications Commission (FCC) was faced with the approval of frequency usage by local agencies when no clear cut plan had been developed to guide the commission in frequency allocation. In short, the state's law enforcement agencies were developing independent systems from a narrow perspective and were operating as individual entities with little regard for the users at large.

Problem Area #2 - The projection and implementation of rational systematic solutions to communication problems statewide. The development of the statewide Law Enforcement Communications Master Plan and the 1972 legislation giving Div-Com implementation authority, did not solve the many problems previously stated. There was general opposition to the plan statewide. The needs assessments of local communication configurations revealed the over crowding of some frequencies and under-use of others. In order to effect an equitable distribution of radio frequencies allocated by the FCC and to enhance service, cooperative arrangements were necessary. Most agencies feared the loss of the "local" police concept or local atonomy and cooperative dispatching was looked upon as inadvisable since many jurisdictions would be unfamiliar to some cooperative dispatchers. Agencies were hesitant to join in a cooperative effort because of differing reporting and operating procedures. Other concerns include higher cost for smaller agencies, different employee benefits, a 20 million dollar price tag for plan implementation and technical problems with such a system(s). Therefore, the problems of plan implementation were added to system configuration and operational problems and needs.

IV. FINDINGS

The methodology section of the report outlines the approach used in the evaluation effort by the BCJPA. Since the assessment was conducted relative to an evaluation design specifying report objectives, the "Findings" section of the report is organized accordingly.

Report Objective #1

Project Fiscal Expenditures - Section III of the report, "Background Data", presents a general overview of the project's history, purpose, legislative requirements and evaluation since first supported with LEAA funds. The project was implemented in 1970-71 to study and assess the scope of the state's communications needs and develop preliminary system design concepts. Considered Phase I and II by DivCom to up-date and modernize the state's communication services and facilities, $143,337 in federal funds and $37,532 in state soft match funds were used to accomplish the first two phases. Phase III, the development of a statewide Law Enforcement Communications Master Plan almost exclusively resorted to federal funding for the plans contractual development - $63,125 (federal), $21,043 (cash match) - which totaled $84,168. Two DivCom engineers were assigned full-time to coordinate and guide the consultant's efforts. Phase IV began the process of technical assistance support services to implement the plan with the funding of grant four (FY '73). Five federally-funded projects have been awarded to continue the support process. Total funds awarded to date is $703,119 ($458,676-federal, $244,442-state match). Refer to Chart 3 for a detailed analysis of funds awarded.

Since July 1972, additional state general revenue funds totaling $194,088 have been used to support the law enforcement communications project. These monies were in the form of engineers' salaries and expenses contributed to the effort, but not made a part of the federal grants' budgets. Therefore, state support during this period totaled $351,000.

Workload/Cost-benefit Assessment - All engineers implementing Phase IV have been performing similar functions and work activities. These activities are divided into four categories:

1. engineering support planning
2. LEAA grant review
3. frequency search and coordination; and
4. comprehensive plan development

Interviews with project staff indicates that category (1) activities consume approximately 25% of the engineer's time. A breakdown of the category into sub-functions would be as follows:

- on-site surveys
- local agency meeting
- system design
- specification development
- agency bid process assistance
- system installation review
- system acceptance assistance

Of the above activities, equipment and system specification development consumed a significant amount of engineering and secretarial staff time. On the basis of five completely developed specifications monthly during 1976, approximately 60 specifications would have required over 600 manhours of work, plus an undetermined

DIVISION OF COMMUNICATIONS
CHART III

70-10-02 - Statewide Communications Study 11/19/70 to 6/30/77

	FEDERAL	MATCH	TOTAL
Personnel	$ 16,020	$ 21,709	$ 37,729
Contractural Services	26,880	21,204	48,084
Travel	-	1,322	1,322
Equipment	1,922	-	1,922
Other Operating Expenses	-	3,399	3,399
TOTAL	$ 44,822	$ 47,634	$ 92,456

71-10-02 - Statewide Communications Study 5/21/71 to 12/31/71

Personnel	13,195	-	13,195
Contractural Services	85,320	39,898	125,218
	98,515	39,898	138,413

72-10-04 - Statewide Telecommunication System 5/1/72 to 5/1/73

Personnel	-	-	-
Contractural Services	63,125	21,043	84,168
	63,125	21,043	84,168

73-10-02 - Statewide Law Enforcement Communications 8/1/73 to 4/3/75

Personnel	33,934	107,675	141,609
Contractural Services	13,978	1,392	15,370
Travel	2,233	-	2,233
Equipment	4,180	-	4,180
Other Operating Expenses	10,269	-	10,269
	64,594	109,067	173,661

74-AS-22-0002 - Statewide Law Enforcement Communications 5/16/75 to 11/13/75

Personnel	13,653	4,415	18,068
Travel	1,483	-	1,483
Equipment	2,323	571	2,894
Other Operating Expenses	3,841	-	3,841
	21,300	4,986	26,286

75-AS-22-C201 - Statewide Law Enforcement Communications 11/14/75 to 6/30/76

Personnel	22,043	7,042	29,085
Travel	5,280	-	5,280
Other Operating Expenses	6,041	-	6,041
	33,364	7,042	40,406

76-A2-22-CA01 - Statewide Law Enforcement Communications 7/1/76 to 6/30/77

Personnel	40,203	7,519	47,722
Travel	10,000	-	10,000
Equipment	10,390	-	10,390
Other Operating Expenses	7,075	-	7,075
	67,668	7,519	75,187

77-A2-22-CE01 - Statewide Law Enforcement Communications 7/1/77 to 6/30/78

Personnel	46,024	7,254	53,278
Travel	8,000	-	8,000
Equipment	3,095	-	3,095
Other Operating Expenses	8,169	-	8,169
	65,288	7,254	72,542

TOTAL OF GRANT AWARDS (ABOVE) BY LINE ITEM

	LEAA	STATE MATCH	TOTAL
Personnel	185,072	155,614	340,686
Contractural Services	189,303	83,537	272,840
Travel	26,996	1,322	28,318
Equipment	21,910	571	22,481
Other Operating Expenses	35,395	3,399	38,794
TOTAL FUNDS	$458,676	$244,443	$703,119
TOTAL % FUNDS	65%	35%	100%

number of hours for secretarial support for typing and finalization. This equates to 1/10 of three complete man-years or roughly $6,000 in state and federal cost.

Staff indicated LEAA grant review tasks to consume approximately 10 to 15 percent per annual period, frequency search and coordination activities to consume three percent to five percent, and assistance in the development of the state's comprehensive criminal justice plan to be approximately two to five percent annually.

Activities noted in the before-listed categories are conducted in accordance with assigned sections of the state. Each law enforcement project engineer is given the responsibility and authority over communications systems in a particular section of the state. The northern and central sections of the state, containing (40) and (15) counties respectively, have been assigned to the federally funded engineers who work exclusively in the law enforcement communications area. The third engineer, assigned the southern section of the state containing 12 counties, is funded from state general revenue funds and is actively working to implement emergency medical service communication systems as well as law enforcement communication systems.

Without the use of a manpower workload study conducted on all project activities, no definitive estimates or cost projections could be made on actual staff activities nor could a general cost analysis be developed to project annual communications savings for local units of government implementing communications systems. As an alternative, three specific examples of cost savings activities employed by the project will be discussed. These include:

1. Procurements utilizing Div-Com specifications;

2. Lease-purchase agreements; and

3. Cooperative dispatch centers per requirements of the State Law Enforcement Communications Plan.

These three examples are more fully explained below:

1. PROCUREMENT UTILIZING DIV-COM SPECIFICATIONS - If Div-Com does not supply agencies with technical specifications for mobile radio communications equipment, equipment manufacturers are willing to develop the specifications. This usually creates a biased bidding situation in that manufacturers' specifications are slanted towards their equipment and in many cases, cause other manufacturers to "no-bid" on system specifications called for in "request for proposals" (RFP). The specifications must be designed for all major equipment manufacturers if a competitive bidding process is to be used. However, if a company has developed the specifications, it can be fairly confident of being awarded the contract. An example of utilizing Div-Com system specifications is illustrated when a 31.3% savings is realized by bidding rather than using Government Services Administration (GSA) prices and discounts. The equipment listed in Table I was part of a total system bid in which 60.8 percent of all equipment was comprised of mobile and portable radios.

Using the 60.8 percentage as a guideline, it can be projected that 39.2 percent of the communications equipment purchased in 1977 was bid from system specifications developed by Div-Com. Total communications expenditures for 1977 have been estimated to be $2,400,000 for local law enforcement agencies. Therefore, $940,800 worth of communications equipment will be procured from specifications. If this equipment were purchased directly from the GSA catalog price lists, less a standard local government discount, a total of $1,369,432 could be expected to be spent. Therefore, an estimated yearly savings of $428,632 can be realized by utilizing the services of Div-Com.

CHART IV -- BID PRICES VS. GSA PRICES

	GSA	BID	QUANTITY	TOTAL COST GSA PRICES	TOTAL COST BID PRICES
Control Console, Desk & Chair	$18,106	$12,930	2	$36,212	$25,860
250 Watt VHF-HB Rpt. CTCSS, Tone Control	3,776	3,013	6	22,656	18,078
Duplexer	514	566	6	3,084	3,396
Control Units	7,507	5,556	2	15,014	11,112
Time/Date Stamp	548	464	2	1,096	928
Antenna	179	197	6	1,074	1,182
Transmission Line	665	458	6	3,990	2,748
TOTAL				$83,128	$63,304

2. LEASE/PURCHASE AGREEMENTS - In many cases, mobile radio vendors attempt to convince law enforcement agencies that a lease purchase procurement method is the best method of obtaining radios.

A major east coast Florida city is a prime example of these vendor techniques. The agency was preparing to enter a lease/purchase agreement when the new agency chief contacted Div-Com requesting a formal on-site survey of his radio communications system. The conclusions of this survey recommended the department buy, not lease, equipment and procure four and five channel radios, not eight channel as recommended by the vendor. A savings of $12,419 could result in following the Div-Com recommendation (See Table below).

SAVING RESULTING FROM DIV-COM SURVEY

30 Portables -	vendor price	$28,740	25 mobiles -	vendor price	$30,638
	state contract	26,272		state contract	20,687
		$ 2,272			$ 9,951

3. ESTABLISH COOPERATIVE DISPATCH CENTERS PER STATE LAW ENFORCEMENT COMMUNICATIONS PLAN - The Cities of Largo, Clearwater and Dunedin are presently operating a law enforcement Cooperative Dispatch Center (CDC). In 1976, the City of Largo became dissatisfied with the arrangement and proposed to establish its own public safety communications center. Largo used many reasons to withdraw from the center, one reason being cost. Largo claimed their share of the center's cost was excessive.

In October of 1976, the Division of Communications performed an extensive study of the CDC. The findings proved Largo was being provided a higher grade of services than the City could provide and at a considerable cost savings. While operating from the center, the Largo citizens were able to have a higher grade of service because the CDC provides three to four complaint operators. Largo could only provide one.

The cost to operate an equivalent center in Largo would be $347,644 per year, while the cost to operate from the CDC is only $202,000 per year. The city can therefore experience a savings of $145,644 per year.

Based on these three examples, an estimated $500,000 in financial benefits will be minimally realized by units of government in Florida during 1977.

Report Objective #2

The FY '76 "Statewide Law Enforcement Communications" project grant concentrated its activities on the accomplishment of seven major project objectives. Based upon reports and files of the Bureau of Criminal Justice Planning and Assistance and the Division of Communications, the following accomplishments have been identified per grant objective.

OBJECTIVES	RESULTS
1. To review all project grants (estimated 150) concerning law enforcement communications projects to ensure compliance with the Master Plan.	1. Two hundred fifty five communications grants were reviewed and appropriate recommendations made to the BCJPA by Div-Com.
2. Improve equipment reliability and serviceability in approximately 119 agencies by providing up-to-date equipment via specifications.	2. Thirty five law enforcement agencies' communications equipment was updated via engineering prepared specifications.
3. By providing system specifications to approximately 63 agencies: (a) reduce inter and intra-agency interference to an acceptable level (approx. 90%) (b) improve intra-agency communications to an acceptable level (approx. 90%)	3. Fifty four law enforcement agencies were provided system specifications meeting the stated objectives.
4. By providing personal/portable system specifications to approx. 15 agencies, improve officer safety & police contact directly with the public.	4. Nine agencies were provided personal/portable systems.

5. Increase police operating effectiveness and, hence, public service by providing audio logging recorder specifications to approx. 23 agencies.	5. Thirteen law enforcement agencies were provided with audio logging recorder specifications.
6. Provide engineering support planning to approximately 160 agencies to ensure efficient and effective system changeovers (change from their present system to the Master Plan System).	6. Three hundred twenty seven agencies were provided engineering consulting support in the areas of system design and planning, propagation studies, frequency searches and recommendations. Fifty-four of these agencies were provided system specifications to upgrade their system to be compatible with the State Master Plan.
7. Provide detailed input to the Communications Section of the State Comprehensive Plan in which recommendations are made on a priority basis for LEAA funding of law enforcement communications systems.	7. Final draft of the 130-page communications section of the state comprehensive plan for funding law enforcement communications systems on a priority basis was submitted to the BCJPA.

As an overall assessment of project accomplishments based upon project objectives, over 100 more LEAA-funded communications grants were processed by the project than originally estimated. Since the FY '76 State Comprehensive Criminal Justice Plan's law enforcement communications budget was reduced from the FY '75 allocation, it is believed that the grants reviewed were for communications component system purchases and not for large total system operations. The development of only 35 equipment and 54 system specifications was significantly lower than the 119 originally projected. The primary determinent of specification development is federal funds awarded for communications improvement to local agencies. Since a higher percentage of awards were for small equipment purchases (radios, etc.) and since agencies have the option of purchasing from a state contract, it is believed that a higher projection was made in the project objectives for equipment specifications. Finally, the project provided engineering support services to approximately 160 more agencies than was anticipated.

In summary, the project's objectives were understood by project management. The results of the FY'76 project was the aggregate achievement of approximately 80% of the originally-stated objectives with the difference being an over-projection of objective workload quantities.

Report Objective #3

The Statewide Law Enforcement Communications Master Plan's creation and legal foundation was presented in Section III(Background Data) of this report. The plan exists as a working document and as such, specifies communications requirements and configurations to be adhered to by all local law enforcement agencies in the state. The Division of Communications procedurally applies the requirement of the plan when analyzing and designing systems. It is used when

reviewing or modifying the requirements of system proposals (equipment and system specifications, grant applications, etc.) The plan's table of contents, introduction and overview is presented in the appendix as appendix 2 for further orientation.

Since its completion in 1973, the plan has been revised twice to rectify frequency allocation and congestion problems. Current indications are that it should be revised again in early 1978.

The plan contains detailed communications requirements and needs through 1982 including equipment requirements for each local agency in the state. Since its development, the plans equipment requirements list has not been officially updated. As a suppliment, the BCJPA and Division of Communications jointly developed and implemented a communications questionnaire to assess the existing system and document the perceived needs of local agencies. The last survey was conducted in April 1977 (see Appendix 3) which resulted in the documentation of agency's existing communication equipment quantities and the projection of equipment needs per agency. Therefore, in reviewing independent and federal grant proposals, Div-Com is applying the requirements of the master plan and the needs assessment prior to the approval of system implementation.

During 1977, the Bureau of Criminal Justice and Div-Com proposed to the Governor's Commission on Criminal Justice Standards and Goals, the adoption of a three-priority level system for the funding of police communication systems. Consideration has been given by the Governor's Commission through its Police Task Force. Although adopted by a communications subcommittee of the Task Force, the Task Force has yet to take affirmative or negative action (see Exhibit 3). Without the concurrance of the Governor's Commission, Div-Com is hesitant in implementing the priority funding system, even though the priority funding system would hasten the implementation of the state's communication Master Plan. The 1972 enabling legislation provides the authority to Div-Com to promulgate required procedures for the plan's implementation.

Report Objective #4

A "Division of Communications Technical Assistance Questionnaire" was sent to 386 law enforcement agencies statewide in September, 1977. The survey was intended to subjectively appraise the quantity and quality of service provided to local agencies by the Division of Communication's Public Safety Section.

The questionnaire asked 11 questions (see Appendix 4) concerning the type of services received by the agency from Div-Com. Fifty-four percent of the 386 agencies surveyed responded. To assure accuracy of analysis, all survey data was key punched and analyzed by a computer information system. Data analysis output was presented on the basis of responses received by the state's regional planning districts (10 regions) and by agency size. Four agency sizes were defined and applied: 1) 0 to 20 sworn personnel; 2) 21 to 50 sworn personnel; 3) 51 to 100 sworn personnel, and 4) 101 or more sworn personnel.

The total number of agency responses by size and regional locations is presented below:

Size 1-20 - 112 agencies or 53.1% of responses
Size 21-50 - 52 agencies or 24.6% of responses
Size 51-100 - 23 agencies or 10.9% of response
Size 101 & over - 24 agencies or 11.4% of responses

Region 1 - 7 agencies or 3.3% of responses
Region 2 - 21 agencies or 10% of responses
Region 3 - 12 agencies or 5.7% of responses
Region 4 - 14 agencies or 6.6% of responses
Region 5 - 13 agencies or 6.2% of responses
Region 6 - 41 agencies or 19.4% of responses
Region 7 - 14 agencies or 6.6% of responses
Region 8 - 20 agencies or 9.5% of responses
Region 9 - 13 agencies or 6.2% of responses
Region 10 - 56 agencies or 26.5% of responses

Based upon the responses of individual questions by individual agencies, some question responses were not applicable and, therefore, the sample size fluctuates from question to question.

The survey's responses to question one indicate that 57.8% of the 211 agencies responding had been informed of the Division's technical assistance services. Only 38.5% of Region Two agencies were aware of the service while 60.7% of Region 10 were unaware of the service. Forty-six percent of the size 0-20 agencies were not aware of the services while 71% to 87.5% of sizes 21 to 50, 51 to 100 and 101 and over were informed of the services. Of those informed of the services, most indicated (question 2 response) that one of the communications engineers had provided the information.

The third question's answers were intended to determine the number and type of agency requesting services from Div-Com. From the 209 agencies responding, 58.9% indicated a request had been made in the past. This ranged from a low of 40% of the agencies in Region Two to a high of 75.6% in Region Six. Fifty percent of the size 0-20 agencies had not requested assistance, while from 66.7% to 87.5% of the 99 agencies in sizes two, three and four had requested services.

Question four responses determined that 92.8% of the agencies requesting assistance received follow-up services from Div-Com. However, Region Four and size 0-20 agencies received less follow-up - 77.8% - and 87.8% respectively.

Question five identified five alternative courses of assistance that could have been provided. These included engineering planning support, general technical assistance, system specification design, system specification approval and a final category - others to be specified. The 116 agency's responses indicated that engineering planning support had been provided in 62% of the cases, 73.3% of the agencies had been provided general technical assistance, 70.7% had been provided system specification design assistance and system specification approval had been provided to 69.8% of the respondents.

Of the assistance provided, 96.5% of the 115 agencies responding to question six indicated satisfactory assistance was provided by Div-Com and that it helped to to improve their communications operations an average or great amount. Responses by agency size correlated equally well with only 5.2% of the size 0-20 agencies (two percent of total sample) expressing that communications operations had been improved very little or none at all.

In 77.1% of the responses, Div-Com was found to recontact/follow-up the initial assistance to assess the quality of service provided. This varied according to agency size from 71.1% in the 0-20 group and 80% in the 101 and over group.

An important aspect of the Div-Com services is the assessment of communications needs in local agencies. Only 46.5% of the respondents to question nine specified contact by Div-Com to determine agency communication needs. The size one agency responses revealed 48.5% of the agency group had not been contacted. Thirty-nine percent of the size 21-50 group also responded negatively.

Seventy agencies indicated that contacts had been made to determine communications needs. Of these, 50% had experienced that on-site visits had been conducted one to four times and 34.5% had never been visited for a needs assessment. Fifty percent of the question's respondents specified that a questionnaire had not been administered, and 24% had not been contacted by telephone.

The final question of the survey was designed to check the awareness of local agencies in understanding the Division of Communication's statutory responsibility with respect to law enforcement communications. Of 204 agencies responding, 50% were not aware of the Division's legal authority. Region One and Two's agencies appear to be 70% unaware, size 0-20 grouping indicated 65.7% unaware and 51.9% of Region Two were unaware. Eighty three to 91% of size 101 and over and group 51 to 100 respectively indicated awareness of the Division's legal mandates.

Analysis of the questionnaire data points to several conclusions. The Division's Public Safety Section is providing the law enforcement community in the state significant levels of quality service. The Section's communications engineers are responsive to the request and inquiries of most agencies, geographically, and by size. The level of satisfaction expressed by the agencies for services provided is a good indicator of the professional and technical capabilities of the engineers. The analysis also indicates that at least one-half of all agencies are unaware of the Division's legislative mandates and authority even through records indicate, with few exceptions, all agencies have been provided some type of technical assistance during the last four years of the project. Law enforcement agencies are not fully informed as to the types of technical assistance services available to them. Finally, most agencies do not feel that their communications needs have been thoroughly assessed.

Report Objective #5

Staff qualifications were analyzed during the assessment. State employment requirements for the position of "communications engineer" minimally include graduation from an accredited four-year college with major course work in electrical engineering and three years of experience in video, radio, data, electronics maintenance or related area of engeineering.

The two staff engineers funded by the federal project are considered to be well qualified with electrical engineering degrees and additional post-graduate work or technical engineering training acquired. Using 1977 as a base year, over 17 years related experience is contributed to the project by the engineering staff. The supervisor for Public Safety (not federally-supported) is considered well qualified with a B.S. and M.S. majoring in engineering and

management; and a minimum of 13 years experience.

Staff employment training was considered as an indicator of how well project engineers were able to maintain working competence with technical improvements in communications systems and design. Employer pre-service training has not been provided as a normal, planned practice. New personnel would be given an orientation period to acquire a working knowledge of existing systems in the state, of the state master plan and operational staff functions.

To facilitate in-service training and as a method to solve common engineering technical problems, weekly training sessions have been developed for all public safety section engineering personnel. At each session staff developed reports, designs, etc. are presented, discussed and analyzed by staff (see appendix 5). From these sessions, it appears that technical training is facilitated and beneficial.

RECOMMENDATIONS

#1 - THE STATEWIDE LAW ENFORCEMENT COMMUNICATIONS PROJECT, AS A COMPONENT OF THE SERVICE OF THE DIVISION OF COMMUNICATIONS, SHOULD BE CONTINUED WITH FUNDING SHIFTED TO STATE GENERAL REVENUE FUNDS.

The 1972 legislation outlining DivCom law enforcement communications authority and responsibility is clear and direct. DivCom maintains legal authorization to direct the development and implementation of the statewide law enforcement plan and total prior approval authority for all communications projects in the state.

Since passage of the 72 legislation and the provision of approximately $671,000 in state and federal funds, approximately $321,000 or 48% of total funds have been with federal funds. Based upon the findings of the evaluation, the history of the project has been effective in moving the state toward coordinated and modern law enforcement communications configurations. Additionally, law enforcement agencies in the state need firm direction and technical engineering assistance as the state's Master Plan is implemented. It appears that the law enforcement community is continuing to rely on and ask for assistance to assure maximum effectiveness in systems operation while minimizing system's design, development and implementation cost. It would appear to be irrational to discontinue a service to local units of government which might result in increased local government expenditures and a non-coordinated law enforcement communications system.

#2 - THE STATEWIDE LAW ENFORCEMENT COMMUNICATIONS MASTER PLAN SHOULD BE REVISED TO INCORPORATE A SYSTEMS NEEDS ANALYSIS AND A SYSTEMS' PRIORITY IMPLEMENTATION PROCESS.

The Master Plan has been revised twice since its development. The Plan is scheduled for revision again in 1978 to re-allign frequency allocations with area needs in the state. As an integral part of the plan's multi-year effectiveness, it is understood that changing technology, and the introduction of new and improved communications devices and techniques, require continuous upgrading and updating of the Plan first completed in 1973.

It is recommended that the plan be revised to incorporate:

(1) COMMUNICATION REQUIREMENTS OF ALL DEPARTMENTS IN THE STATE AND;

(2) A PRIORITY IMPLEMENTATION PROCESS

DIV-COM SHOULD ASSESS AND DOCUMENT THE REQUIRED COMMUNICATIONS NEEDS OF ALL LOCAL LAW ENFORCEMENT AGENCIES IN THE STATE.

The needs assessment should identify each agency's minimal equipment needs for Master Plan compliance, as opposed to what an agency would like to do that would exceed the requirement of the plan.

The second incorporated revision to the Plan (the priority implementation process) would be in accordance with its legal authority to implement and coordinate the plan with necessary rules and regulations and with an affected administrative agreement with the Bureau of Criminal Justice. The revision, a priority implementation process, would designate the priority for implementing types of communications equipment and systems by region with the use of state or federal funds. Systems implemented with local revenues and in compliance with the

Master Plan would not be affected. However, the incorporation of such a revision to the plan would be more acceptable to the law enforcement community if it were first adopted by the Governor's Commission on Criminal Justice Standards and Goals (see Report Objective #3).

The primary intent of these recommendations is to implement the state communications plan in a rational, objective manner with a minimum of resources.

#3 - THE DIVISION OF COMMUNICATIONS SHOULD DEVELOP AND IMPLEMENT STANDARDIZED EQUIPMENT AND SYSTEM ENGINEERING SPECIFICATIONS TO BE REVISED PERIODICALLY.

The promulgation of specifications by Div-Com is a time consuming staff activity for which equipment has been purchased to standardize a significant number of types of specifications. The engineering staff should be immediately directed to develop and apply standardized specifications in their design and development activities. This should allow several thousand man hours to be used for additional technical assistance and Master Plan revision.

#4 - THE DIVISION OF COMMUNICATIONS SHOULD DEVELOP AND PUBLISH AN INFORMATION PAMPHLET FOR DISTRIBUTION TO ALL LAW ENFORCEMENT AGENCIES STATING THE DIVISION'S STATUTORY AUTHORITY AND RESPONSIBILITY, TYPES OF SERVICES AVAILABLE TO AGENCIES AND GENERAL REQUIREMENTS OF THE STATE MASTER PLAN.

The evaluation effort noted that a significant number of agencies in the state were unaware and uninformed of Div-Com's legal status, authority, the services available to agencies and general provisions of the Master Plan. The information pamphlet should help to rectify the problem if it is disseminated.

APPENDIX

APPENDIX #1

Administrative Agreement
Div-Com & BCJPA

RECEIVED 23
JUL 24 1974
[illegible] Reubin O'D Askew
[illegible] Governor

STATE OF FLORIDA

DEPARTMENT OF ADMINISTRATION

DIVISION OF STATE PLANNING

BUREAU OF CRIMINAL JUSTICE PLANNING AND ASSISTANCE

Earl M. Starnes
STATE PLANNING DIRECTOR

Bryant Building
620 South Meridian Street
Tallahassee, Florida 32304
Telephone (904) 488 6001

L. K. Ireland, Jr.
SECRETARY OF ADMINISTRATION

Check
c.c. Admin
KSN

MEMORANDUM

TO: Mr. Donald R. Allen, Director, Division of Communications
Mr. Jack D. Kane, Director, Department of General Services
Mr. L. K. Ireland, Jr., Secretary, Department of Administration

FROM: Mr. Helge Swanson, Bureau Chief, Bureau of Criminal Justice Planning and Assistance

SUBJECT: ADMINISTRATIVE AGREEMENT

DATE: July 22, 1974

Attached is a copy of an Administrative Agreement that will formalize the operational procedures between the Bureau of Criminal Justice Planning and Assistance and the Division of Communications. Please keep one of the attached copies for your records and return the original to our office signed. Your attention to this matter will be appreciated.

JWS/HS/cm

Attachments

Helge Swanson

THIS AGREEMENT entered into this day of 1974, by and between the Bureau of Criminal Justice Planning and Assistance within the Division of State Planning, Department of Administration and the Division of Communications within the Department of General Services.

WHEREAS, it is the intention of the parties to set forth mutually acceptable procedures for the purpose of processing subgrant applications for Law Enforcement Assistance Administration funds that would support the upgrading and systemization of law enforcement communications capabilities in Florida; and

WHEREAS, the Division of Communications within the Department of General Services has the responsibility to develop and assist in the implementation of a county and municipal law enforcement communication plan for Florida pursuant to Section 287.29, Florida Statutes; and

WHEREAS, no law enforcement communications system shall be established or present system altered without the prior approval of the Division of Communications pursuant to Chapter 287, Florida Statutes; and

WHEREAS, the Division of Communications has the responsibility in part to develop a state plan for communications services for all state agencies and to control and approve the purchase, lease and use of all communications equipment and facilities including communications services provided as any part of this total system to be used by the state or any of its agencies; and

WHEREAS, the Bureau of Criminal Justice Planning and Assistance has the responsibility to process Law Enforcement Assistance Administration funds; and

WHEREAS, Florida's Comprehensive Criminal Justice Plan for 1973 provided for funding of communications equipment, related hardware and technical services to support the implementation of a system or subsystem in conformance with the State Communications Master Plan and prohibits the acquisition of unrelated equipment and renovations to facilities under Program Area A-1 Law Enforcement Communications Improvement, subprogram areas A-1.01 - Master Plan Implementation, and A-1.02 - Communications Systems Improvement; and

WHEREAS, the parties desire to set forth the administrative responsibilities of the Division of Communications which shall be endorsed by the Bureau of Criminal Justice Planning and Assistance with regard to the priority of funding of state agencies and local units of government as well as project implementation criteria that shall be required of those agencies seeking funds under the Law Enforcement Assistance Administration program:

W I T N E S S E T H:

The parties hereto agree as follows:

1. In order to be eligible for funding all units of government requesting funding for communications improvement must meet the rules, regulations, standards and implementation criteria as set forth by the

state comprehensive plan for criminal justice, the State Communications Master Plan, Florida Statutes and the Law Enforcement Assistance Administration guidelines.

2. The technical aspects of all law enforcement communications projects shall be reviewed and approved by the Division of Communications prior to funding by the Bureau of Criminal Justice Planning and Assistance.

3. All applicants for funding must be local units of government or approved state agencies having law enforcement responsibilities.

4. Limited availability of funds necessitates that first priority for funding shall be provided to high crime incidence areas and those areas designated by the Division of Communications to effectively and efficiently implement the statewide master plan.

5. The Division of Communications shall recommend to the Bureau of Criminal Justice Planning and Assistance and to the grantee, methods of acquisition of communications equipment, systems or services.

6. Where any unit of local government undertakes to apply for assistance under Law Enforcement Assistance Administration programs, they shall be required to comply with the requirements of the federal office of management and budget Circular A-95 which was developed to encourage added cooperation with state and local governments and the evaluation, review and coordination of federal assistance programs and projects. The Bureau of Criminal Justice Planning and Assistance fulfills local requirements in submission of applications to the State of Florida, Department of Administration, which functions as a state planning and development

clearinghouse. This provision shall not be interpreted as being a modification of the requirements of local applicants of the Bureau of Criminal Justice Planning and Assistance in complying with the requirements of OMB Circular A-95 which were previously set forth.

7. This agreement may be terminated by any party on fifteen (15) days' written notice to the other parties which are a part of this Agreement. This Agreement shall remain in full force and effect until modified or dissolved by the principals.

Jack D. Kane, Director
Department of General Services
Date: 7/31/74

L. K. Ireland, Jr., Secretary
Department of Administration
Date:

Donald R. Allen, Director
Division of Communications
Date: 7/25/74

Earl M. Starnes, Director
Division of State Planning
Date:

LEGALITY AND FORM APPROVED
GENERAL COUNSEL
DEPARTMENT OF GENERAL SERVICES
BY

APPENDIX #2

STATEWIDE LAW ENFORCEMENT COMMUNICATIONS MASTER PLAN

Introduction & Table of Contents

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents the plan for the organization of communications networks for all municipal and county law enforcement agencies within the state of Florida excluding the counties of Broward, Dade, Monroe and Palm Beach. This four county area is presently developing a separate law enforcement communication plan which together with this document represents the total Statewide Law Enforcement Communications Plan. The communications requirements for each agency included in this plan (approximately 282) were developed from a description of each agency's communications equipment, facilities and operational characteristics compiled by Atlantic Research Corporation during an earlier phase of this program.[1] Projected communications requirements were also developed for the next 10 years based on 10-year population trends provided by the Department of General Services.

The "Preliminary Plan"[2] was completed on March 28, 1973, and was transmitted to the Florida Sheriffs and Police Chiefs. Eleven regional meetings were held during the month of April 1973 to present the Preliminary Plan and to provide the opportunity for each agency to participate in the refinement of the plan. The result of this effort is presented herein as the "Statewide Law Enforcement Communications Plan."

Section 2.0 of this report describes the rationale used in developing the communications requirements. These include the required channel allocations, the coordination requirements, the dispatching requirements, the logging requirements, the immediate equipment requirements and the telephone requirements. Quantitative requirements for each agency both immediate and through 1982 are presented in Sections 4.0 through 8.0.

Four appendices are included which describe some basic considerations inherent in understanding and implementing this plan. Appendix A describes the mathematical method for determining maximum loading of a channel. Appendix B outlines the factors that must be considered in establishing a cooperative dispatch center and includes a typical Inter-Local Agreement that would represent the contract among the member agencies of a cooperative dispatch center. Appendix C contains an analysis of geographic separation required for interference-free operation. Appendix D presents a typical Operational Procedures Handbook which would be utilized by the participating agencies in a cooperative dispatch communications system.

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[1] "County and Municipal Law Enforcement Communications in the State of Florida," Atlantic Research Corporation, 1972. Prepared for the Department of General Services, Division of Communications, Tallahassee, Florida.

[2] "Preliminary Plan for County and Municipal Law Enforcement Communications in the State of Florida," Atlantic Research Corporation, March 1973, prepared for the Department of General Services, Division of Communications, Tallahassee, Florida.

1.1 Overview of the Plan

The Florida Communications Plan for county and municipal law enforcement agencies is based upon a concept involving establishment of 56 mobile radio zones within the State (see Section 3.0). The approach is compatible with many alternate modes of operation, thereby permitting maximum flexibility and option at the local level. A mobile radio zone refers to a geographical area within which all agencies participate in a coordinated communications police system. Sufficient channels are provided in each mobile radio zone to allow interference-free and lightly loaded channel conditions for all agencies.

Large agencies within a mobile radio zone are assigned dedicated primary channels since these agencies are of sufficient size to justify independent operation. Smaller agencies will share the use of a primary channel. In addition, districtwide coordination channels will be allocated for interagency coordination between mobile radio zones.

Consolidation of communications services is highly recommended within each mobile radio zone. In other words, it is believed that establishment of one or more central dispatch facilities to serve the smaller agencies within each mobile radio zone will provide the most economical, professional and efficient operation. Strict centralization is not essential to compliance with this plan. However, the plan does prescribe the use of shared channels and common base station equipment.

Within the police mobile radio service there are three frequency bands which can be used. Namely, VHF low band, VHF high band, and UHF. Because of the frequency congestion and the severe skip interference in the VHF low band, this plan, for the most part, recommends police communications in the VHF high band or the UHF band. The UHF band is ideally suited for large municipal police departments because of its low susceptibility to man-made noise, because it does not cause skip interference and is therefore more "controllable," and because UHF frequencies tend to eliminate dead spots in and around large buildings. Therefore, municipalities within Florida, large enough to justify independent operation, will generally be allocated frequencies in the UHF band. A notable exception to this is the city of St. Petersburg which, because of the present worth of equipment, will remain in VHF high band.

VHF high-band frequencies, while slightly more susceptible to man-made noise than UHF, tend to propagate further because of lower diffraction losses. Therefore, VHF high band is better suited to longer range, countywide operation than is UHF. The plan utilizes VHF high band for sheriffs' operations and for small cities and villages which will share primary channels. A notable exception to this plan is the District I Plan which was developed prior to this program and which is presently being implemented.

This plan contains the guidelines and the detailed requirements and recommendations for each police agency within the state of Florida for improving police communications. The intent is that it be a flexible plan and one which can be modified with good justification.

The plan has been developed such that the county and municipal agencies have considerable option in their mode of operation. As already indicated, cooperative dispatching is highly recommended, but the use of common radio channels and base equipment is an acceptable alternative and one which would allow continued independent operation, but would still permit centralization at a later date if so desired.

In developing a cooperative dispatch facility, there are various options to be considered. In some instances it may be appropriate for the sheriff to assume operation of the center, while in other instances, the sheriff's operation may be completely independent. An alternative used successfully in many counties throughout the country is that of establishing an independent communications agency with representation from each law enforcement agency participating.

Throughout the plan two-frequency channel operation is recommended for primary dispatch channels; i.e., separate frequencies for base and mobile transmissions. This recommendation has been made to minimize interference between co-channel users. However, it is planned to retain single frequency cimplex operation for the intercity channel (155.370 MHz) and for the emergency coordination or mutual aid channels, such as 154.950 MHz.

This plan presents both the recommended frequencies and the required number of channels for each mobile radio zone. Since the frequency resources avaiiable to police mobile radio service are limited, it has not been possible, nor would it be desirable, to assign a separate channel to each agency. Smaller agencies must therefore share channels. It is believed, however, that the plan will result in a much more equitable channel assignment than that which exists and one in which virtually all channels within an area will be police-only with light loading and minimum co-channel interference. A detailed frequency plan identifying specific frequencies for each agency is included in Section 3.6. This will involve crystal changes for some agencies, frequency band changes for others, and no change for still others.

Features of this communication's plan are summarized on Table 1.1.

Table 1.1. Features of the Florida L.E. Communications Plan.

- Ten-year Plan
- Establishment of coordinated mobile radio zones
- Multichannel capability for all agencies
- Dedicated primary channels for large agencies
- Shared channels for small agencies
- District-wide coordination channels, mobile and base
- Use of shared common base equipment
- Recommended cooperative dispatch centers
- Two frequency channels to minimize interference
- Tone coded squelch
- Toll-free, easy-to-remember telephone numbering system
- New frequency plan providing equitable distribution of channels with reduced congestion and interference
- Standardized police radio procedures

APPENDIX #3

Law Enforcement Communications Questionnaire

PLEASE RETURN WITHIN 15 DAYS

SURVEY
Division of Communications
Technical Assistance Questionnaire

Please answer the following questions as accurately and briefly as possible.

1. Has your office been informed that the Division of Communications, State Department of General Services, provides communications technical assistance services?

   Yes _____ No _____ Unknown _____

2. If yes, please identify the primary source of the information (Who informed you of these services?).

   _____

   _____

3. Has your office requested assistance from the Division of Communications?

   Yes _____ No _____ Unknown _____

4. Did the Division of Communications provide assistance to your agency following your request?

   Yes _____ No _____ Unknown _____

5. If provided, what type of assistance was furnished? (Check all that apply)

   - Engineering planning support _____
   - General technical assistance _____
   - System specification design _____
   - System specification approval _____
   - Other (Specify) _____ _____

   _____

6. If assistance was provided, was your agency generally satisfied?

   Yes _____ No _____

   If NO, why not? _____

   _____

   _____

(CONTINUED ON BACK)

SURVEY
Page Two

7. Did the assistance help to improve the operation of your communications system?

None _____
Very little _____
Average amount _____
Great amount _____

8. If assistance was provided, did the Division of Communications recontact/follow-up the assistance with your agency to assess the quality of assistance provided?

Yes_____ No_____ Unknown _____

9. Has the Division of Communications contacted your agency to determine communications needs?

Yes_____ No_____ Unknown _____

10. If yes, how many contacts have been made in the past two years?

Number of site visits _____
Number of questionnaires _____
Number of telephone inquiries _____
Other (Number & Type(s)) _____
_____
_____

Unknown _____

11. Are you aware of the Division of Communications' Statuatory responsibility with respect to law enforcement communications?

Yes_____ No_____

At your option, please complete the following:

Agency _____

Name _____

APPENDIX #4

Div-Com T.A. Questionnaire

LAW ENFORCEMENT COMMUNICATIONS QUESTIONNAIRE

Name/Title _____

Agency _____

Address _____

Phone # _____

1. In the table below, please list the quantity of each type of equipment presently owned or leased by your agency.

Equipment	Quantity	Channel Capacity
Repeater base stations	_____	
Simplex base stations	_____	_____
Mobile radios	_____	_____
Portable radios	_____	_____
Logging tape recorders	_____	_____
Dispatch console	_____	_____
Dispatch desk top control unit	_____	_____
Antenna towers	_____	
Emergency power generator:		
At dispatch facility	_____	
At base/repeater stations	_____	
Satellite receiver sites	_____	
Total satellite receivers	_____	
Vehicular Repeaters	_____	

(over)

2. Please list your present communication equipment needs based upon the items listed in question #1. Provide an explanation for each item of need.

Equipment	Explanation

3. What areas of improvement are needed to increase your operational efficiency of your communications system?

APPENDIX #5

Project Inservice Training Reports

APPENDIX #5

PORTABLE RADIO
ANTENNA
TEST REPORT

By

D. J. Lynch

State of Florida
Department of General Services
Division of Communications
June, 1977

PORTABLE RADIO ANTENNA TEST RESULTS

ABSTRACT

Tests were conducted in VHF low band, VHF high band, and UHF to determine the use environment losses (ground plane inefficiency and body loss) of standard portable radio antennas compared with a 1/4 wavelength antenna on a vehicle and, hence, to a 1/2 wave dipole. The output from the portable radio was first fed into the mobile antenna (reference) and then the antenna on the portable radio. In both cases, the signal was received on a base station 2-5 miles away. The signal levels were measured using HP-355 attenuators in conjunction with the base receiver. For each portable radio, four (4) compass directions (90° apart) were tested to obtain the data and at least two (2) directions (4 for VHF low band) for each mobile for each location. The mobile antenna VSWR was measured as well as transmission line length and these effects were taken into account in the calculations. In all cases, the radio antenna was operated in a vertical position.

VHF LOW BAND

The radio tested was a Repco 10-8 (large size) with an 18-inch telescoping antenna using loading internal to the radio. The mobile antenna was a 1/4 wavelength mounted on the driver's rear cowl (1976 Dodge Monaco). Tests were run from two different locations with the portable radio at head height with the following results:

Location #1

Vehicle 1/4 wave 11.6 dB stronger than portable telescoping antenna
Standard deviation of portable antenna 1.4 dB
Standard deviation of mobile antenna 3.6 dB

Location #2

Vehicle 1/4 wave 11.4 dB stronger than portable telescoping antenna
Standard deviation of portable antenna 1.0 dB
Standard deviation of mobile antenna 2.5 dB
Mobile antenna VSWR 1.7:1, Frequency 45 MHz

3.5 dB[1] must be added to the above data to equate the 1/4 wavelength mobile antenna on the rear cowl to a half wavelength dipole.

The final average data for VHF low band portable radio antennas is:

VHF LOW BAND (Continued)

Telescoping antenna loss with reference to a half wavelength dipole 15 dB
Standard deviation of portable radio antenna 1.2 dB
Standard deviation of cowl mounted mobile antenna 3.1 dB

VHF HIGH BAND

The radios tested in VHF high band were a GE PE and a Repco 10-2 (small size). The GE had a helical (6") antenna and the Repco had a 1/4 wavelength and a helical antenna. The mobile antenna was a 1/4 wavelength whip mounted on the center roof (1976 Plymouth Fury). The following data was recorded:

Radio and Antenna Type	dB Below Mobile Antenna	Standard Deviation
GE - 1/4 wave on vehicle	----	1 dB
GE helical on radio, head height	11.6 dB	2.6 dB
Repco 1/4 wave on vehicle	----	1 dB
Repco 1/4 wave on radio, head height	8.1 dB	2.1 dB
Repco helical on radio, head height	11.5 dB	3.4 dB
Repco helical on radio, hip level	22.8 dB	4.6 dB

Mobile antenna VSWR 1:1, Frequency 159 MHz

Of interest is the close correlation between the GE with the helical antenna and the Repco with the helical antenna.

To equate the loss of the portable radio antenna to a half wave dipole, the difference between the quarter-wave monopole on the vehicle roof and a half-wave dipole at the same level, 1.0 dB[2] must be added to the above data.

The final average data for VHF high band portable radio antennas is:

Antenna Type	Below 1/2 Wave Dipole	Standard Deviation
1/4 wave antenna, head height	9.1 dB	2.1 dB
helical antenna, head height	12.6 dB	3.0 dB
helical antenna, hip level	23.8 dB	4.6 dB

UHF

The radios tested in UHF were a Motorola HT-220 and a Repco 10-2 (small size). Both radios had 1/4 wave flexible and helical (2") antennas available for testing. The mobile antenna was a 1/4 wavelength whip mounted on the center roof of a compact auto (1969 Mustang). The following data was recorded:

Radio and Antenna Type	dB Below Mobile Antenna	Standard Deviation
Repco 1/4 wave on vehicle	----	0.5 dB
Repco 1/4 wave on radio, head height	2.3 dB	0.6 dB
Repco 1/4 wave on radio, hip level	10.3 dB	6.7 dB
Repco helical on radio, head height	4.3 dB	0.5 dB
Motorola 1/4 wave on vehicle	----	0.5 dB
Motorola 1/4 wave on radio, head height	3 dB	1.2 dB
Motorola 1/4 wave on radio, hip level	12.8 dB	7.2 dB
Motorola helical on radio, head height	7.5 dB	1.5 dB
Motorola helical on radio, hip level	15.3 dB	4.7 dB

Mobile antenna VSWR 1.55:1, Frequency 458 MHz

The above figures generally were less than expected. Because the roof area of the vehicle used was 22% smaller than the roof area of the vehicle used for VHF high band (standard size vehicle), a correction factor of 1 dB (10 log roof area ratio) was added to the above figures to equate to a standard size vehicle roof.

To equate the above quarter wave data to a half wave dipole, 1.0 dB[3] must also be added, as in VHF high band. The final average data for UHF portable radio antennas is:

Antenna Type	Below 1/2 Wave Dipole	Standard Deviation
1/4 wave antenna, head height	4.6 dB	0.9 dB
1/4 wave antenna, hip level	13.5 dB	6.9 dB
helical antenna, head height	7.9 dB	1.0 dB
helical antenna, hip level	17.3 dB	4.7 dB

1,2,3 Horn, D.W., "Selection of Vehicular Antenna Configuration and Location through Use of Radiation Pattern." 1973 VTG Conference of the IEEE, October, 1973.

APPENDIX #6

RADIO PROPAGATION

DESIGN GUIDE

By

D. J. LYNCH

DEPARTMENT OF GENERAL SERVICES
DIVISION OF COMMUNICATIONS
BUREAU OF COMMUNICATIONS ENGINEERING

Revised July 1977

COMMUNICATIONS SYSTEM DESIGN GUIDE

INTRODUCTION

This document is intended to serve as the overall design guide for Land Mobile Communications Systems within the Bureau of Communications Engineering. As such, it will delineate system success criteria (performance parameters), contain a set of procedures, list pertinent references (both formal and informal), and identify machine programs to be used.

It should be emphasized that Land Mobile Radio Design is a discipline of many compromises; therefore, this design guide is to be a guide only and not the final answer. Each case must be decided upon an individual basis using the total knowledge available.

This design guide is intended to be used in conjunction with the Division of Communications Radio Propagation Paper. As such, it will supply typical values for use in the range equation below:

$$S = P + G_T + G_R - L_P - L_D - L_S - L_N - L_{TA} - L_{RA} - L_R \quad (1)$$

S = Signal Strength (dBw)

P = Power Output (dBw)

G_T = Gain of Transmit Antenna (dB)

G_R = Gain of Receive Antenna (dB)

L_P = Plane Earth Propagation Loss (dB)

L_D = Diffraction Loss (dB)

L_S = Terrain Shadow Loss (dB) (Hill, Foliage and Building Loss)

L_N = Noise Degradation (dB)

L_{TA} = Transmit Transmission Line Loss (dB)

L_{RA} = Receive Transmission Line Loss (dB)

L_R = Reliability Degradation (dB)

PART 1 - BASE & MOBILE DESIGN

Before starting the actual design, the coverage range of communication must first be determined. This is usually obtained from the using agency but may be determined by the designer in the case of a Statewide system. Once the coverage area is determined, the degradation factors must then be determined.

PLANE EARTH LOSS AND DIFFRACTION LOSS

The required coverage can be obtained in two basic ways. Either a relatively low antenna and a large ERP or a high antenna and a low ERP may be used. It is generally preferable to use a high antenna and a low ERP to obtain the required coverage. This arrangement tends to produce less troposcatter interference than the low antenna, high ERP case. At UHF the higher antenna is especially advantageous because diffraction loss and terrain loss are higher at UHF than at lower frequencies.

If the range is known, the plane earth propagation loss (L_p) and the diffraction loss (L_D) can be obtained from the curves of Figures 4 and 5 if antenna height above average terrain is known. If the furthest coverage distance is within line of sight, the diffraction loss is not applicable. The height above average terrain for the base antenna is determined as follows:

$$h_b = h_t + h_e - h_a \quad (2)$$

Where h_b is height above average terrain, h_t is the height of the antenna above ground, h_e is the elevation above sea level at the tower sight and h_a is the average terrain elevation. The average terrain elevation, h_a is determined from topographic maps. It is suggested that elevations be taken every mile or half-mile from the base to the distance coverage is desired in the direction of interest (usually the furthest or most difficult radial). The elevation readings taken every mile or half-mile are then averaged to determine the average terrain elevation (h_a) along the particular radial. The formula above is generalized but should be applicable for all but the most unusual topographic conditions.

TERRAIN SHADOW LOSS

The terrain shadow loss, which includes hill loss, foliage, and building loss, is found by determining the type of area to be covered.

The average hill height is determined by using topographic maps of the area of concern. The height of hills along the most difficult radial or radial of interest is determined. These hill heights are then averaged to determine the average hill height.

To obtain the hill heights along a radial, the elevation readings used to determine average terrain elevation are again used. As an example, if the elevations going away from the base station are 100, 150, and 125 feet, the hill height is 150-125 or 25 feet since only

an elevation lower than the previous elevation represents an obstruction. This method has possible errors in that very sharp or very gradual hills may not be accurately represented. Sharp hills may not fully appear on the map and a gradual hill may be mistaken for several smaller hills. In either case, the probable error would be to underestimate the hill height. Plotting the hills on earth profile paper is very helpful in accurately presenting the terrain and is recommended. If one very large hill or sharp topographic discontinuity occurs along a path, then that obstruction height should be used as the average hill height. In all cases, the hill height is the difference in elevation between the bottom of the valley and the top of the hill.

For hill loss, the 50% curves of Figure 1 have shown close agreement with data from the test program and should be used for calculations.

Foliage and suburban building losses recommended in the test program are presented along with the standard deviations.

Foliage & Building Losses in dB

Freq. Band	Light Foliage	Std. Dev.	Heavy Foliage	Std. Dev.	Dense Foliage	Std. Dev.	Suburban w/light Fol.	Std. Dev.
VHF Low Band	.1	5.2	2.8	4.8	8	6.3	9.2	7.6
VHF High Band	2	5.3	7.7	4.9	10.1	3	11.1	3.8
UHF	7.9	1.7	10.1	4.3	9.4	3.6	12.7	3.8

The higher standard deviations for low band are due to the smaller number of measurements taken in low band. Light foliage consists of rural areas with low bushes with few trees and buildings; areas south of Orlando are an example of this type foliage. Heavy foliage consists of concentrations of large trees such as found near Tallahassee and much of the northern part of Florida. Dense foliage is sugar cane, or other 6-10 foot high dense obstructions in a particular area. Suburban with light foliage is single-story residences and businesses with a small percentage of taller structures and light tree cover. In suburban with heavy foliage or urban areas, the values in the table will have to be increased. Test and other report data indicates that in urban areas losses at UHF, VHF high band and VHF low band are approximately 23 dB, 18 dB, and 15 dB respectively. For suburban with heavy foliage areas not specifically covered, loss factors between suburban with light foliage and urban should be chosen. Also, medium foliage areas would have loss factors between light and heavy.

NOISE DEGRADATION

Noise degradation, due primarily to vehicular ignition noise and power line noise can be determined from FCC and Test program data. The values are based on FCC data since that data consisted of a greater number of tests. No standard deviation is included because the FCC data was generally as high as our test data plus the standard deviation. Noise degradation factors based on 20 dB quieting sensitivities of -146, -143, and -143 dbw for VHF low, VHF high, and UHF bands respectively are as follows:

Noise Degradation Factors dB

	Low Band	High Band	UHF
Base Stations			
Low Noise Level	2	0	0
Av Noise Level	6	3	1
High Noise Level	14	10	4
Vehicle 65 MPH	16 3*	5	0

*With Noise Blanker

For base stations, average noise level can be assumed if the base antenna is at least 300 feet from a heavily traveled road or high voltage (50 kv or greater) power line. If the antenna is closer to the road or other noise source, then an increase above average levels should be assumed.

Indications are that high noise levels are approached in very highly industrialized areas or locations with a large amount of nearby vehicular traffic or near high voltage power lines.

When a directional antenna is used, the noise degradation factor must be evaluated in light of the antenna direction. If the major lobe of the antenna points toward a highly traveled road or other noise source, the noise degradation factor must be increased; conversely, if the major lobe of the antenna points away from noise sources, the noise degradation factor can be decreased.

The vehicle noise degradation factors are for vehicles with resistance plug wires and will vary somewhat depending on type of vehicle and traffic conditions. In lieu of more complete data, these values for vehicles should be used.

In some cases, it may be necessary to perform a noise survey of an area. This is a difficult task since simulating the base antenna and proposed height above ground may prove to be unfeasible. If another nearby station can be found, it may be utilized for the noise test. Alternately, a mobile can be used but it will require noise readings in all directions from the proposed fixed station to a distance of approximately 1000 feet.

ANTENNA GAIN

Gains of mobile antennas must be referenced to a half wave dipole for proper calculation of the plane earth loss. It is typical for manufacturers to reference mobile antennas to a ¼ wave whip. Based on data measured by Antenna Specialists and the Division of Communications, a ¼ wave stainless steel whip on an auto roof is -1.2 dB with reference to a half wave dipole at low band, high band and UHF. This value is different than the same antenna mounted on a tower in free space.

The following average gain values are recommended for use in calculations. They are with reference to a ½ wave dipole and all mobile antenna gains are referenced to 6 feet height with the exception of low band where the effective height, based on ground conductivity must be taken into account. The effective height for antennas is obtained from Figure 2. A ground conductivity map of Florida is shown in Figure 7. High speed operation deflects the mobile antenna from vertical and reduces the gain; therefore, the high speed gain figure should be used in the design of systems where the vehicle will operate at high speed (100 mph).

Mobile Antenna Gain

With Respect to Half Wave Dipole

Low Band	Stationary Gain	High Speed Gain	Standard Deviation
¼ wave on center roof	-1.2 dB	-1.9 dB	1.8
¼ wave on rear cowl	-3.5 dB	-4.5 dB	1.9
Base loaded on center roof	-1.6 dB	-2.3 dB	1.8
Base loaded on center trunk	-3.5 dB	-4.5 dB	2.0
Base loaded on rear cowl	-4.5 dB	-5.5 dB	2.0
High Band			
5/8 wave on center roof	1.1 dB	-3.0 dB	0.5
5/8 wave on center trunk	0.6 dB	-3.5 dB	1.0
¼ wave on center roof	-1.2 dB	-2.2 dB	0.5
¼ wave on center trunk	-3.5 dB	-4.5 dB	1.5
5/8 wave on rear cowl	0.1 dB	-4.0 dB	1.1
UHF			
¼ wave on center roof	-1.2 dB	-1.2 dB	0.0
5/8 wave disguised front cowl mount	-3.4 dB	-4.0 dB	3.1
5/4 wave colinear on rear cowl	-0.5 dB	-4.0 dB	2.0
5/4 wave colinear on center roof	3.8 dB	0.3 dB	0.0
5/4 wave colinear on center trunk	0.5 dB	-3.0 dB	1.4
Low Profile on center roof	-2.0 dB	-2.0 dB	0.0

The high band 5/8 wave antenna is an ASP-800 and the UHF 5/4 wave antenna is an ASP-830 or a DB-705. The low band base loaded antenna is an ASP-730, the low band ¼ wave is the standard whip with the spring at the base. The high band ¼ wave antenna is an average between the

.046" diameter whip and the .100" diameter whip. The .100" whip has slightly better and the .046" whip slightly worse high speed performance. Gain of the antennas is without obstructions such as lights or sirens on the auto roof. Reduction of the above gains by about 1 dB are in order if there are obstructions on the auto roof. The gain of base station antennas is taken from manufacturers specifications which are commonly referenced to a half wave dipole. The only typical exception to this is the ground plane antenna. Because of up pattern tilt, the gain of it is 1.7 dB below a half wave dipole at zero degrees elevation.

SIGNAL STRENGTH REQUIREMENTS

The minimum usuable signal strength required for a land mobile voice system is that which produces 12 dB SINAD at the receiver output. This signal level is quite noisy and causes fatigue when listening for extended periods. Because of this, 20 dB quieting is a more appropriate design level. For most radios, 20 dB quieting is approximately 17 dB SINAD.

RELIABILITY DEGRADATION

The reliability degradation is an additional loss added to obtain a probability of communications greater than fifty percent. The reliability degradation is determined by multiplying the standard deviation of both the antenna gain and foliage loss by a multiplication factor and then taking the square root of the sum of the squares of these and the terrain hill reliability factor. The terrain hill 90% reliability factor is the difference between the 50% and 10% curves of Figure 1 and is plotted in Figure 3. The multiplication factor used depends upon the probability desired. For 90 percent probability, the multiplication factor is 1.3, for 95 percent, it is 1.64. An example for 90 percent reliability using high band with a ¼ wave whip on the center trunk, suburban with light foliage and 20 foot hills follows:

> The mobile antenna standard deviation is 1.5 dB, the foliage standard deviation is 3.8 dB and the terrain reliability factor is 5.5 dB from Figure 3.
>
> The mobile antenna and foliage reliability factors are then determined from the standard deviations:
>
> 3.8 x 1.3 = 4.94 dB foliage reliability factor
> 1.5 x 1.3 = 1.95 dB antenna reliability factor

$$\text{Reliability degradation} = \sqrt{\underset{\text{(rel. factor)}}{(\text{mob. ant.})^2} + \underset{\text{factor)}^2}{(\text{terrain rel.} + (\text{foliage rel. factor})^2}} \quad (3)$$

$$\text{Reliability} = \sqrt{(1.95)^2 + (5.5)^2 + (4.94)^2} = \sqrt{58.4} = 7.63 \text{ dB}$$

In the case of terrain reliability factor, the values in Figure 3 are

equivalent to a 90% probability and hence can be put directly into equation 3 if the desired probability is 90%. For terrain hill reliability other than 90%, data other than Figure 3 will have to be used. For 95% reliability, it is recommended that the data in Figure 3 be increased by 1.25. For most land mobile design, a 90% probability factor is normally used.

TRANSMISSION LINE LOSSES

Transmission lines for mobiles are usually either RG-58, RG-8, or other similar 50 ohm coaxial cables. At 450 MHz, 100 feet of RG-58 has 8 dB-more loss than the same amount of RG-8, so if the run is over 10 feet at UHF, RG-58 should not be used unless the excess loss can be tolerated in the system. Also of note is that the maximum power rating for RG-58 is 80 watts at 450 MHz and at 104°F. At 140°F (60°C) the maximum power is only 37 watts. At high band, the power ratings are 150 watts and 69 watts respectively for RG-58. For high power at VHF and UHF, RG-303 or Proflex 450 is recommended.

Transmission lines used for base stations are usually 1/2 or 7/8 inch foam type with the 7/8 inch used for the longer runs at the higher frequencies.

The following table gives losses of common transmission lines in dB per 100 feet.

Transmission Line Losses

	Low Band	High Band	UHF
RG58	3.3	6.8	13
RG303	2.4	5.0	9.5
Proflex 450	1.8	3.5	6.9
RG213 (RG8)	1.3	2.7	5.2
1/2" LDF foam	0.45	0.85	1.6
7/8" LDF foam	0.25	0.45	0.85
7/8" air	0.24	0.44	0.83

POWER OUTPUT

The power output of the transmitter must be in the form of decibels above one watt or dBw for use in equation 1. Since the power is in dBw, the signal level will also be in dBw.

MACHINE PROGRAMS

System design calculations may also be determined by utilizing the Division's Monroe calculator with appropriate programs. The programs are identified as follows:

Program 1	Free space loss between half wave dipoles
Program 2	Base Antenna Height Determination - Calculates base antenna height required for specific coverage distance.
Program 3	Signal Strength Determination - Calculates signal strength for specific distance, power, antenna height, frequency, hill height, losses, antenna gain, etc. Plane earth, diffraction and hill height losses are calculated by the program.
Program 4	Coverage Distance Determination - Calculates coverage distance for specific signal strength, power, antenna height, antenna gain, frequency, hill height, losses, etc. Plane earth, diffraction and hill height losses are calculated by the program.
Program 5	Troposcatter signal strength determination for Florida. Most accurate between 100 and 200 miles.
Program 6	Intermodulation determination up to seven frequencies taken two at a time.

PART 2 - PERSONAL PORTABLE DESIGN

In designing personal portable systems, the range equation, equation (1) is still applicable but several of the factors must be changed to account for operation with personal portables.

ANTENNA GAIN

The gain of the personal portable radio antenna is reduced from that of a vehicular ground plane or half wave dipole because of a poor ground plane and closeness to the person operating, "body loss." The following antenna losses are for a typical portable unit and are with reference to a half wave dipole. The height for calculation purposes is six feet.

Portable Radio Antenna Losses in dB
Half-wave Dipole Reference

Antenna Configuration Head Height	VHF Low Band Loss	VHF Low Band Std.Dev.	VHF High Band Loss	VHF High Band Std.Dev.	UHF Band Loss	UHF Band Std.Dev.
¼ Wave	*15	1.2	9.1	2.1	4.6	0.9
Helical (Coil Spring)			12.6	3.0	7.9	1.0
Hip Level						
¼ Wave			---	---	13.5	6.9
Helical (Coil Spring)			23.8	4.6	17.3	4.7

*18 in telescoping with internal radio loading to achieve resonance

As might be expected, the efficiency of the portable antenna system increases with increasing frequency. This is primarily due to the radio length (ground plane) coming closer to a quarter wavelength at the operating frequency.

TERRAIN SHADOW LOSS

The shadow loss term in the range equation is usually different for operation from a personal portable and depends greatly on the type of operation contemplated.

Sometimes hill loss can be omitted, but foliage and man-made obstacle loss will have to be included. In addition, loss to the inside of buildings and autos usually has to be included. The exact types of losses to use depend upon the system location and requirements. The hill and foliage losses were presented previously so losses to the inside of buildings and to the inside of autos are presented below:

Building Losses in dB

Type Structure	VHF High Band Loss	St. Dev.	UHF Band Loss	St. Dev.
Wood frame	4	4.2	5.4	2.2
Reinforced concrete & steel office building	30	8	27.6	2.6
Stucco &-Wood	11	3.2	15.3	3.5
Shopping Centers	20	8	20	8

The building losses are referenced to the portable operating in the street outside the building at head level and vary widely with position in the building. The above are median losses encountered inside the buildings.

Auto Losses in dB

Configuration	VHF High Band Loss	St. Dev.	UHF BAND Loss	St. Dev.
Shoulder level	15	5.9	10.7	5.9
Hip level	23.4	7.2	15.1	6.0

The auto losses are with reference to operating outside the vehicle in the same location at shoulder level. They are median losses and vary due to position.

If extensive operation from inside a vehicle is planned, a vehicle charger with a mobile antenna is highly recommended. In this configuration, the personal portable can be considered a mobile transceiver and coverage can be determined by Part 1 of this guide.

NOISE DEGRADATION

Because the antenna system of the portable radio is considerably less efficient than a mobile antenna, the noise degradation factor is reduced by the antenna loss factor. To determine noise degradation, subtract the antenna loss factor from the noise degradation. If the resulting number is less than zero, use zero for noise degradation.

RELIABILITY DEGRADATION

The reliability degradation factor is determined by the same procedure as for base and mobile systems; although with portable systems the terms in equation 3 are usually different. In a portable system, the portable antenna standard deviation and the building standard deviation are usually used and the hill reliability factor may be utilized depending on the given system.

PLANE EARTH LOSS AND DIFFRACTION LOSS

For portable systems, the plane earth propagation loss is utilized in the same manner as for mobile systems, but in most portable systems, the diffraction loss is not applicable since operation occurs before the radio horizon. Figure 6 represents the distance to the horizon; for Florida, K = 1.5 is acceptable.

VOTING SYSTEM ADVANTAGE

The voting system advantage that occurs in a multi-receiver system allows the use of fewer receiver sites to cover an area with a specific reliability than would normally be required. For two stations, it is such that the overlapping coverage areas for 68 percent reliability for each station actually produces a 90 percent combined reliability. To obtain a 68 percent reliability, the standard deviations are multiplied by 0.45 instead of 1.3 as was done previously to obtain the 90 percent reliability. There is additional information on portable system design in the Systems Application Manual.

PAGER DESIGN

Even though paging receivers may have sensitivities in a 50 ohm system as good as portable transceivers, paging receivers require more signal for proper operation. This is because antennas for paging receivers are less efficient. In some cases, they may be as much as 25 db less efficient than 1/4 wave whips.

Because of this, it is customary for manufacturers to specify field strength required in UV/Meter for a specific receiving level. To utilize the propagation equation for design, the field strength must be converted to microvolts in a 50 ohm system. This is accomplished by the following equation:

$$V = \sqrt{\frac{50AE}{377}^2}$$

Where V is signal in volts, A is the effective cross sectional area of a dipole and E is the field strength in volts. For low band, high band and UHF, A is equal to 5.8, 0.52 and 0.058 respectively.

The following table is presented to assist in determining microvolts from field strength.

Field Strength	Signal Strength Microvolts in a 50 ohm system using 1/2 wave dipole 45 MHZ	150 MHZ	450 MHZ
1 uv/m	0.88 uv	0.26 uv	0.088 uv
10 uv/m	8.8 uv	2.6 uv	0.88 uv
20 uv/m	17.6 uv	5.2 uv	1.76 uv
30 uv/m -	26.4 uv	7.8 uv	2.64 uv

The signal strength in microvolts, corresponding to the proper field strength in the above table, is the receiver sensitivity that is used with equation one and zero dB is used for antenna gain. In actuality, the antenna gain is much below a half wave dipole and the sensitivity is usually less than one microvolt.

Other than the differences in antenna efficiency, pager system design is identical to personal portable design. For purposes of design, it is assumed the above degradations include body loss. The effective height of the pager is five feet except in VHF low band where the effect of ground conductivity must be taken into accout. (See Antenna Gain in Part 1).

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Okumura, Y., ETAL., "Field Strength and Its Variability in VHF and UHF Land Mobile Radio Service," Review of the Electrical Communication Laboratory, Sept. - Oct., 1968.

Horn, D. W., "Selection of Vehicular Antenna Configuration and Location through Use of Radiation Pattern," 1973 VTG Conference of the IEEE, October, 1973.

Two Way Personal Radio System Design, General Electric Systems Application Manual, December, 1972.

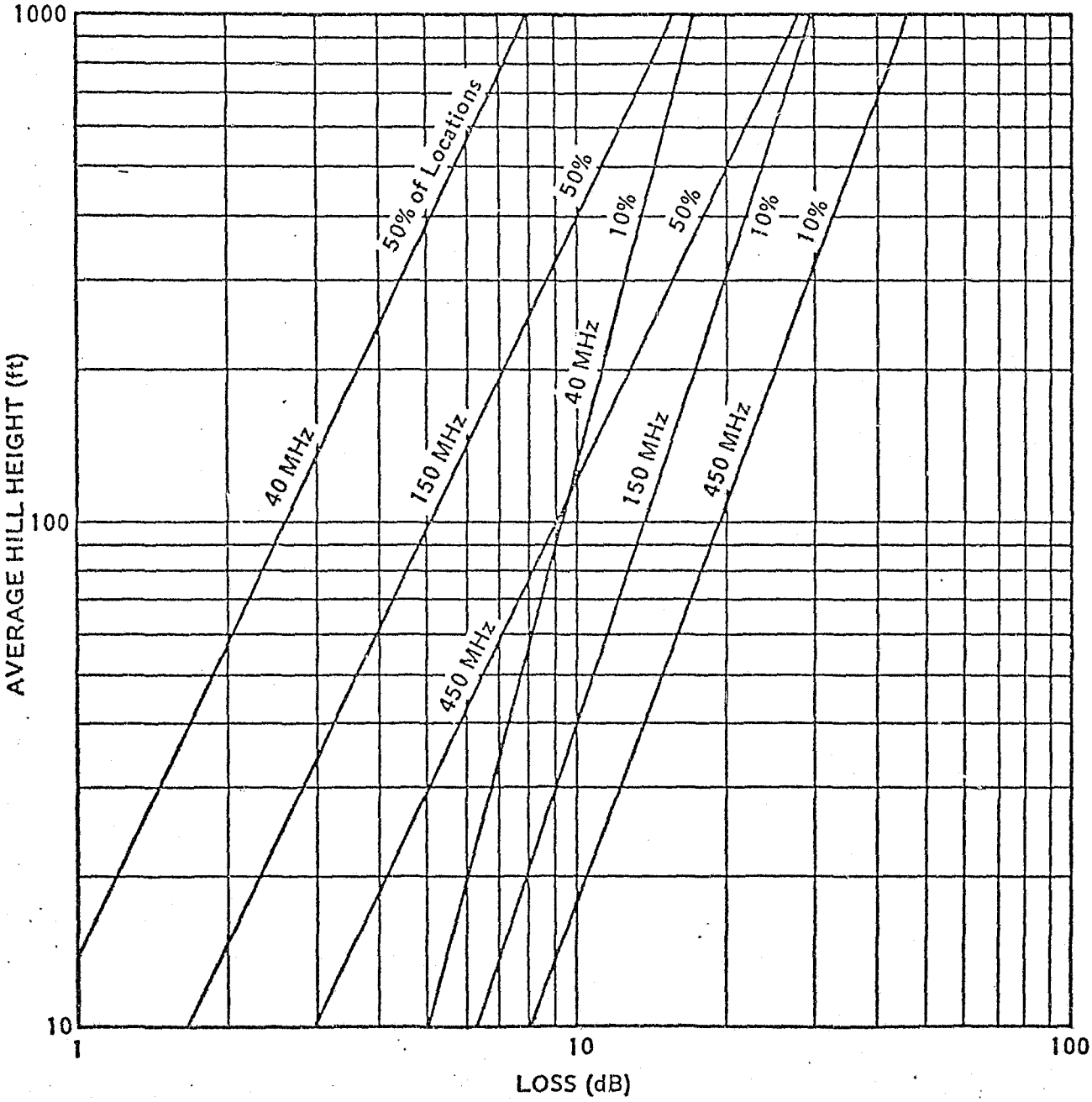


FIGURE 1

Terrain Hill Loss Exceeded in 50% and 90% of Locations

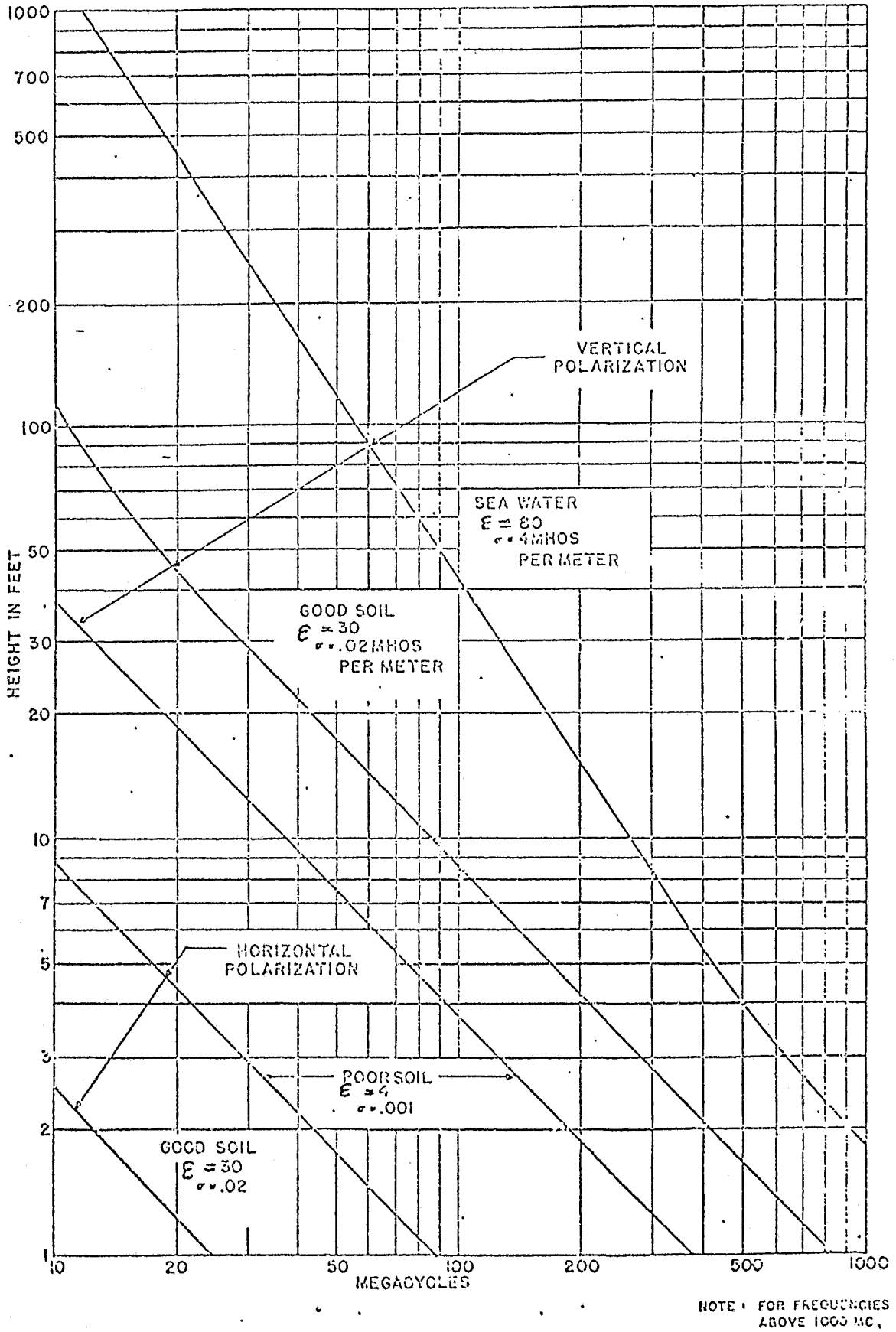


FIGURE 2

Minimum Effective Antenna Height

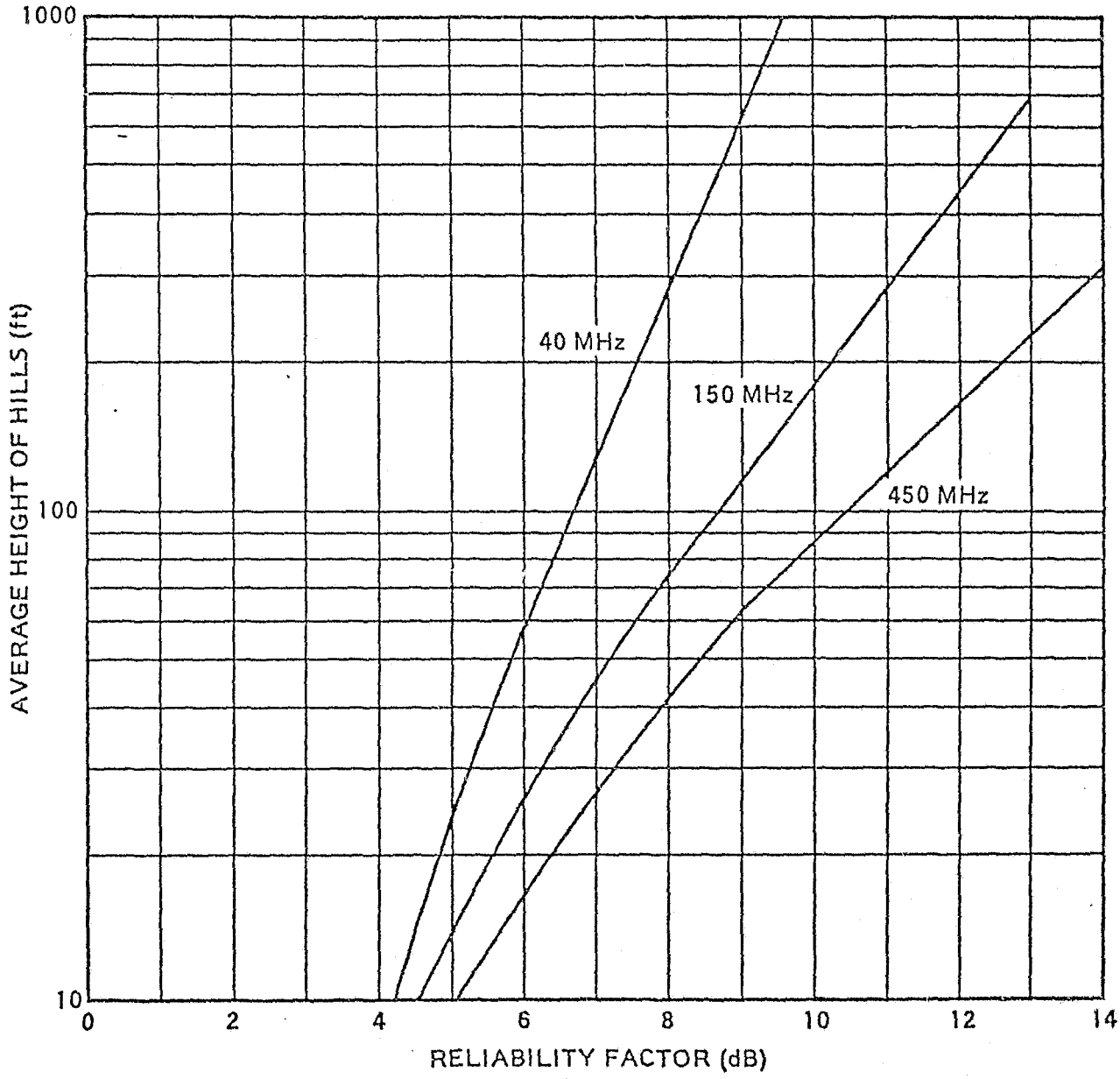


Figure 3 Terrain Reliability Factor. (90%)

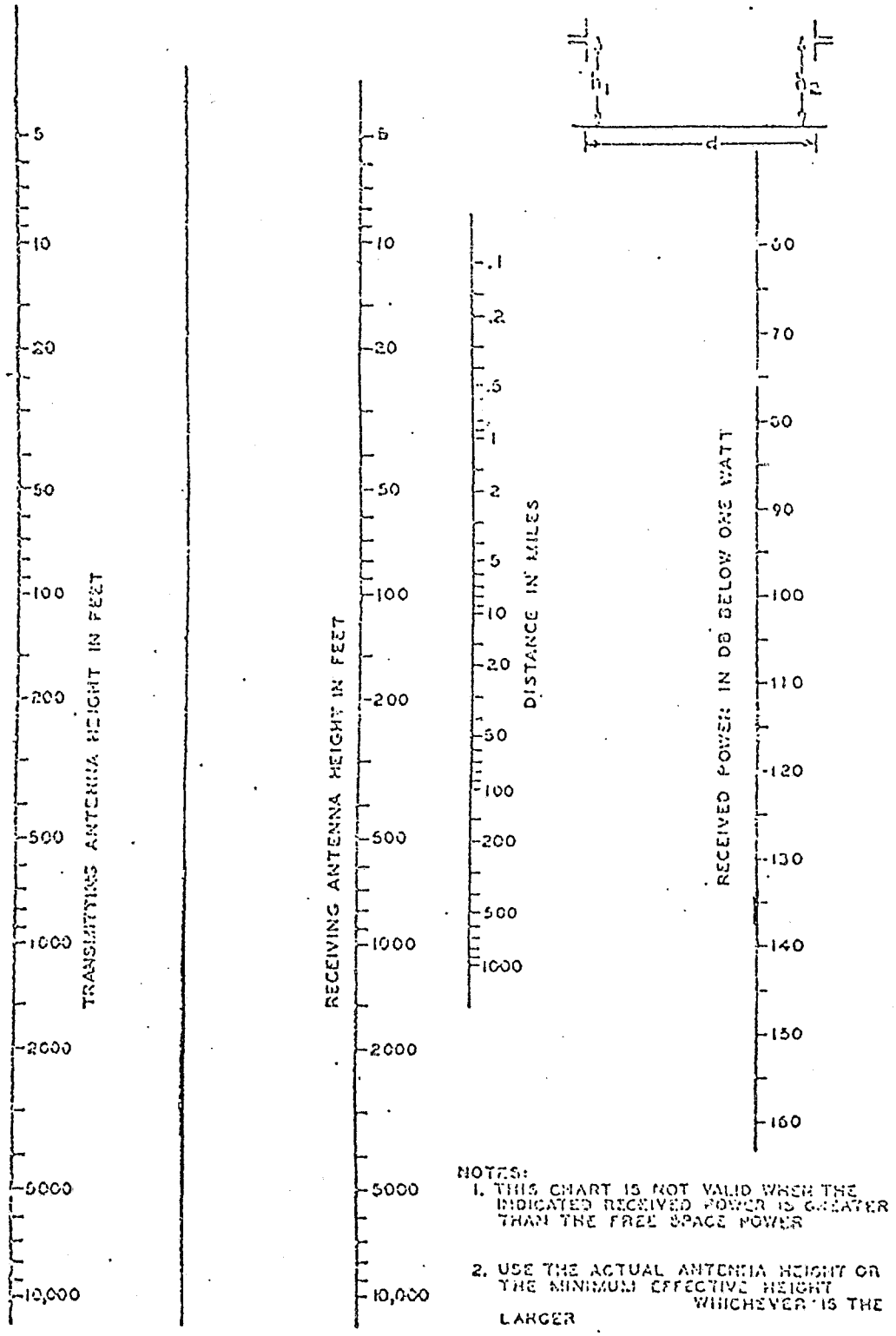
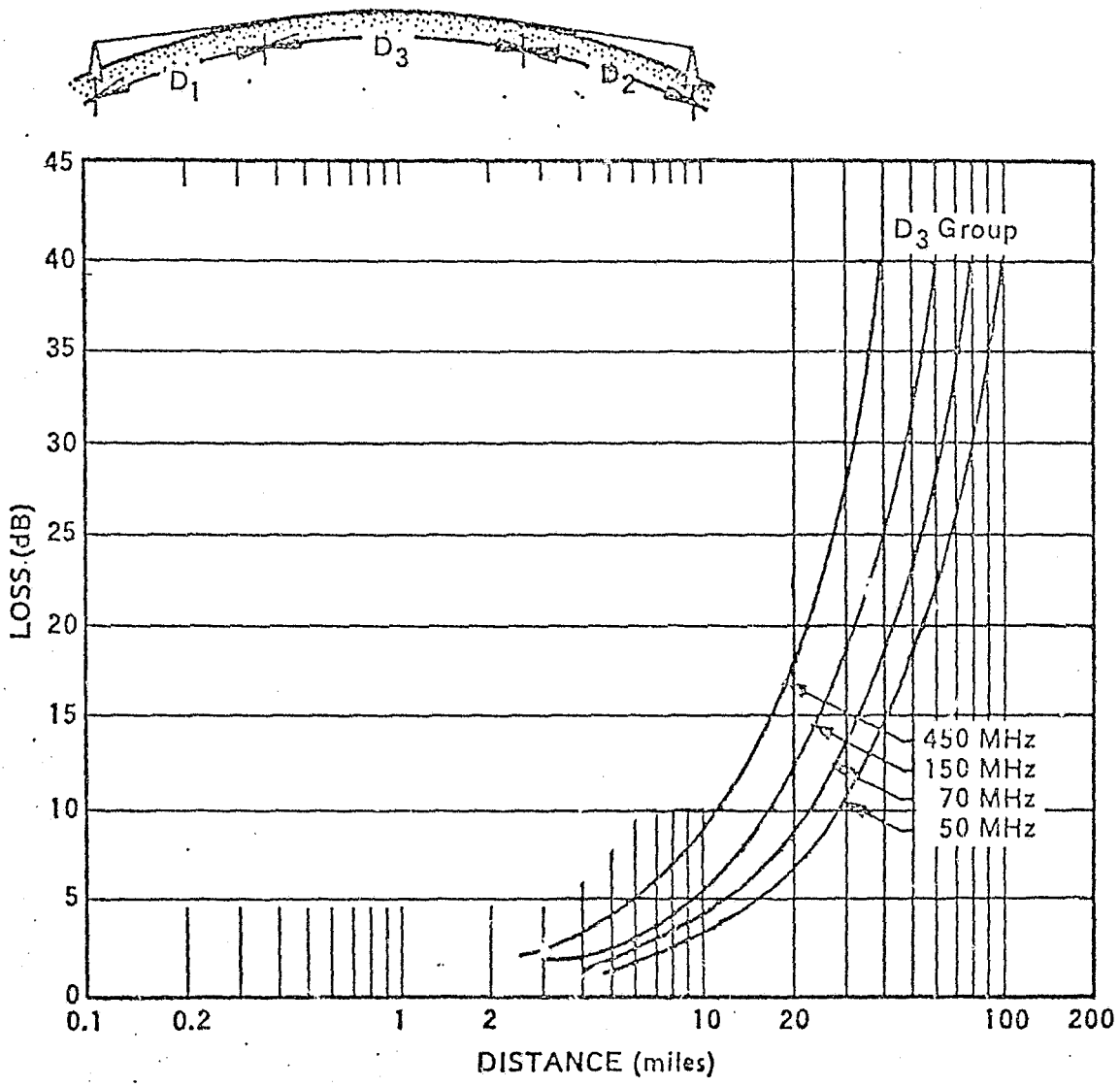


FIGURE 4

Received Power Over Plane Earth
between Half-Wave Dipoles, 1 Watt Radiated



To Calculate Loss Over Paths Beyond Line-of-Sight:

Determine D_1 and D_2 (distance to horizon) (K=4/3)
Subtract (D_1 +D_2) from total path distance to determine D_3.
Determine diffraction loss by finding intersection of D_3 distance and appropriate frequency.

Figure 5 Diffraction Loss Curves.

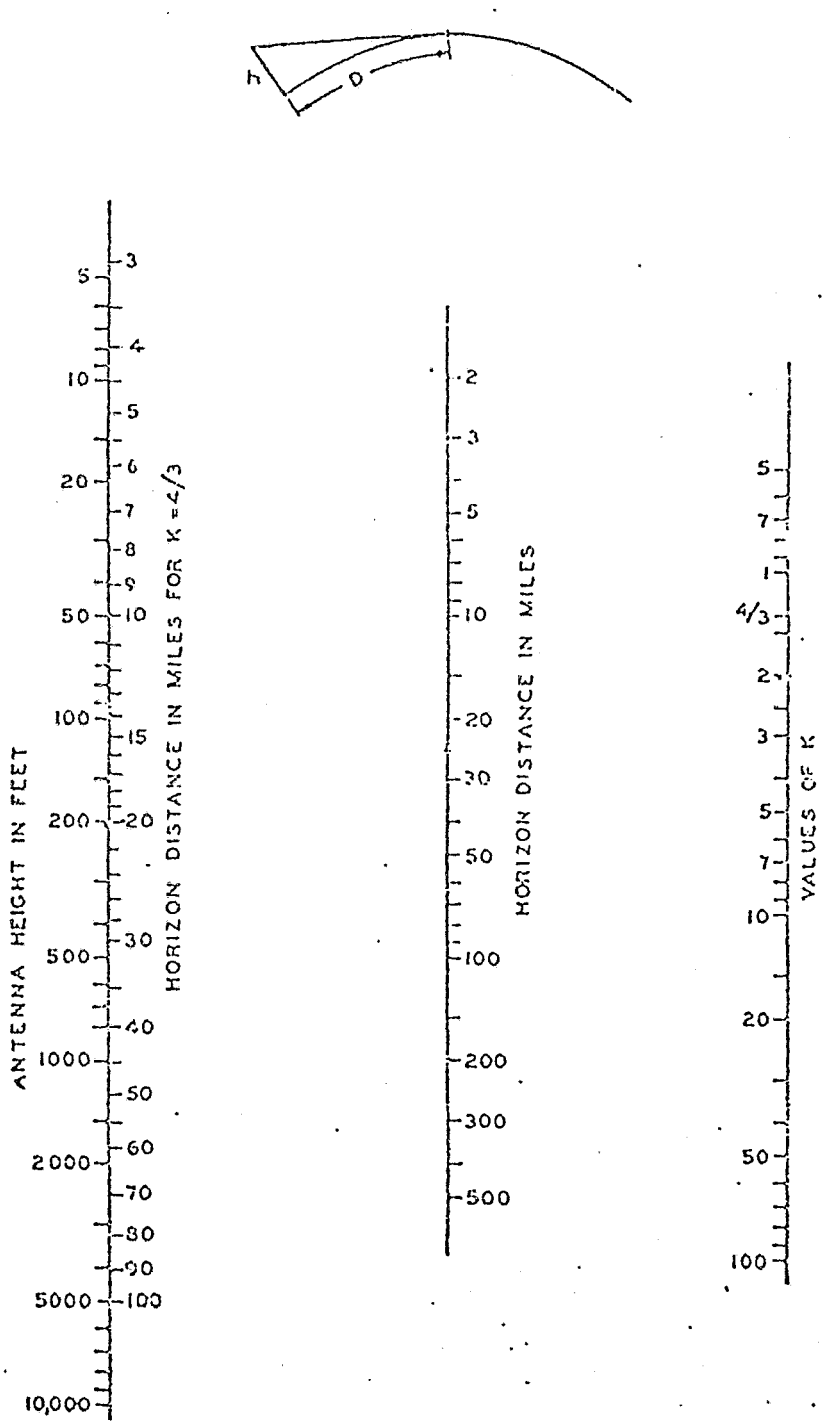


FIGURE 6

Distance to Horizon

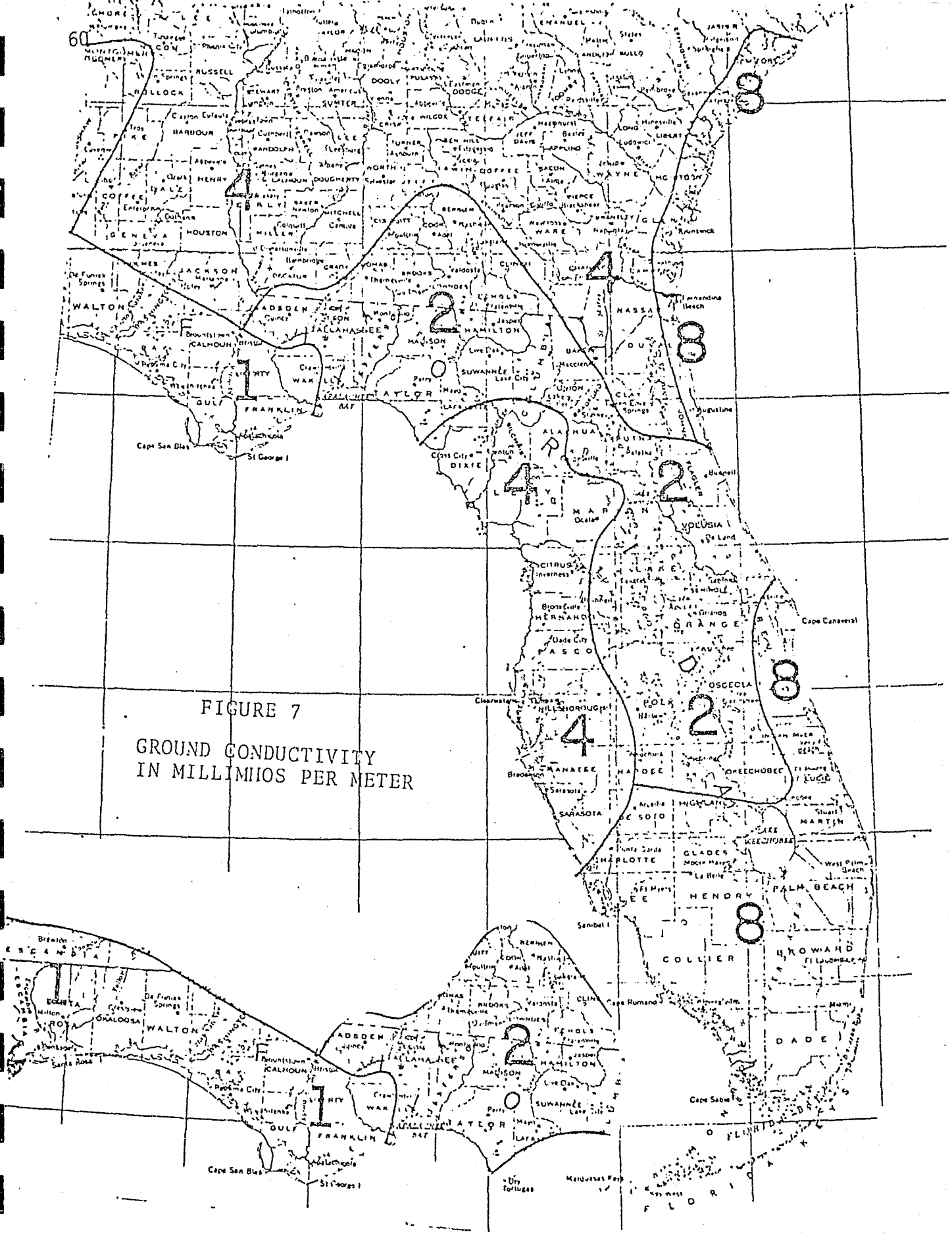


FIGURE 7

GROUND CONDUCTIVITY
IN MILLIMHOS PER METER

END