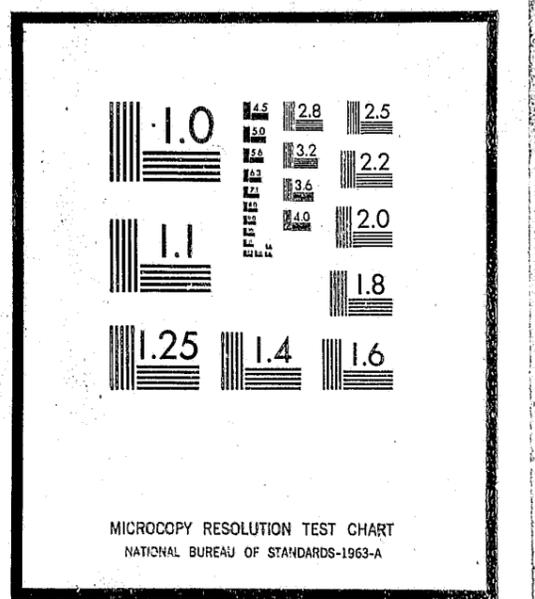


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U.S. DEPARTMENT OF JUSTICE  
LAW ENFORCEMENT ASSISTANCE ADMINISTRATION  
NATIONAL CRIMINAL JUSTICE REFERENCE SERVICE  
WASHINGTON, D.C. 20531

Date filmed

6/2/76

R-76-107

LAW ENFORCEMENT ASSISTANCE ADMINISTRATION  
POLICE TECHNICAL ASSISTANCE REPORT

SUBJECT:

(AL)  
Montgomery, Alabama, Communications System  
Problem Investigation

REPORT NUMBER:

75-97

FOR:

Montgomery, Alabama, Police Department  
Montgomery Population: 145,000  
Montgomery Area: 196 square miles  
Police Department Personnel (Sworn): 401  
(Total): 452

CONTRACTOR:

Westinghouse Justice Institute

CONSULTANT:

Richard C. Banta

CONTRACT NUMBER:

J-LEAA-003-76

DATE:

February 6, 1976

Foreword

This request for technical assistance was concerned with evaluating means of overcoming inadequacies in the Montgomery, Alabama, Police Department radio communications system.

Requesting Agency: Montgomery, Alabama, Police Department,  
Chief E. L. Wright, Jr.

State Planning Agency: Alabama Law Enforcement Planning Agency,  
Mr. Robert G. "Bo" Davis

Approving Agency: LEAA Region IV (Atlanta),  
Mr. Donald M. Manson, Systems Specialist

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1. INTRODUCTION

The Alabama Law Enforcement Planning Agency (ALEPA) desires to ensure that adequate law enforcement communications are being achieved by all law enforcement agencies and requested that the "in state" communications engineering expertise be complemented by engineering assistance in reviewing the Montgomery, Alabama, law enforcement communications system. Technical assistance was requested to investigate the "dead spots" and interstate interference that is experienced by the Montgomery Police Department, to evaluate the existing communications system, and to provide recommendations for improvement. The technical assistance provided was structured to permit the Consultant's participation as a team member in an "ad hoc" group comprised of members of the Alabama Law Enforcement Planning Agency, the ALEPA Communications Technical Advisory Committee, the State Office of Telecommunications, and the Regional Office Systems Specialist. This committee reviewed in detail the law enforcement communications system in Montgomery, Alabama; several system changes that had been made in dealing with the local interference conditions; and the causes for communication interference caused by out-of-state agencies. The Consultant visited both Jackson, Mississippi, and Atlanta, Georgia, to review the Police Department's communications systems and discuss the interference situations with radio engineers in both of these cities.

During the course of performing this technical assistance, the Consultant discussed the Montgomery communications system with the following individuals:

LEAA

ORO Region IV, Mr. Donald Manson, System Specialist

Alabama

Mr. William Yates, ALEPA Communications Specialist  
Chief E. L. Wright, Jr., Montgomery Chief of Police  
Mr. N. Butler, State Office of Telecommunications  
Lieutenant C. E. Pyle, Communications Technical Advisory  
Committee (CTAC)  
Mr. T. Norwood, Communications (CTAC)  
Mr. Robert Champion, City of Montgomery Communications  
Engineer  
Mr. T. Garrett, Communications Technical Advisory Committee  
(CTAC)  
Mr. A. Plan, General Electric Regional Sales Office  
(Equipment Supplier)  
Mr. Ralph Williams, Montgomery Police Dispatcher  
Officer Reynolds, Montgomery Police Dispatcher  
Officer Jones, Montgomery Police Dispatcher

Mississippi

Mr. George E. Donovan, Superintendent of Communications  
for Jackson

Sergeant C. C. Gholson, Jackson Police Department

Captain Fisher, Jackson Police Department

Mr. Glenn Robinson, Mississippi Division of Law Enforcement  
Assistance

Georgia

Mr. S. Flynt, State Office of Telecommunications

Mr. T. Case, State Office of Telecommunications

Mr. R. Billings, Atlanta Police Department Communications  
Specialist

2. UNDERSTANDING OF THE PROBLEM

For some time, the City of Montgomery has been experiencing problems with their existing communications system. As channel usage has increased, the severity of these problems has become increasingly noticeable. These problems have been described by the Police Department, the Alabama Office of Telecommunications, the ALEPA Communications Technical Advisory Committee, and the City Communications Engineer as falling in two areas: (a) Car-to-car coverage, and (b) interference. Both of these problems occur frequently and hinder the Police Department's normal operations.

A great deal of "in state" communications expertise is available and has resulted in many system changes being made to improve the communications system performance. This expertise has explored both near-term and long-term system improvements and has taken significant steps to improve performance. Since the interference problems involved other areas (Jackson, Mississippi; Atlanta, Georgia; and others) not in Alabama, a radio engineer provided under the National Technical Assistance contract was requested to supplement the State's expertise in reviewing and recommending improvements to the situation.

The Consultant was requested to conduct a brief review of the Alabama Law Enforcement Communications System Master Plan, to review the communications system details in Montgomery, and to coordinate the interstate analysis of the communications systems that were identified as causing interference with the Montgomery Police Department Communications System. Site visits to Montgomery, Jackson, and Atlanta were made to establish the detailed situation that exists and to explore the systems impact that would result from the final recommendations.

### 3. ANALYSIS OF THE PROBLEM

The approach followed by the Consultant in reviewing the Montgomery communications system consisted of an information-gathering period in which the statewide law enforcement communication plan was reviewed and detailed discussions were conducted with all individuals who were familiar with the police communications systems configurations in Montgomery, Jackson and Atlanta. This information was assembled into a systematic description of the system characteristics, and an engineering assessment was made of the situation. The recommendations that resulted from this analysis are based on both observed and expected system performance for the configuration that presently exist in the cities involved.

#### 3.1 System Descriptions

The Alabama Law Enforcement Communications Plan outlined several guidelines that mold the structure of Alabama Law Enforcement Communications Systems. These planning guidelines allow for individual flexibility to meet special requirements yet provide for orderly changes and system improvements to be made. The existing Montgomery Communications System complies with the intent of this overall State plan.

Information gathered during the site visit to Montgomery showed that the Police Department consists of approximately 320 sworn officers, covers an area of about 400 square miles, and serves a population of approximately 170,000. The Montgomery, Alabama, Police Communications System is authorized to operate on five VHF band channels from two base station transmitter antenna sites. Both of the locations are in use. The authorized frequencies and their locations are listed below:

<u>Frequency</u>	<u>Location</u>
155.520 MHz	420 N. Jackson Street
155.190 MHz	420 N. Jackson Street
155.625 MHz	420 N. Jackson Street
155.415 MHz	420 N. Jackson Street
155.415 MHz	California Street & Upper Wetumpka
155.010 MHz	California Street & Upper Wetumpka

All channels are operated in the single-frequency simplex mode. The transmitters at the Police Station Tower site are operating at reduced power (approximately 55 watts) and those at the remote site at their authorized power of 330 watts. All antennas are 6-dB omnidirectional types. The antennas at the Police Station are located on a 200-foot radio tower, with the receiver antenna mounted on the top, thus making its total effective height approximately 219 feet. The antennas at the remote site are located on an 80-foot tower. The receivers at the Police

Station site have had some filtering added to reduce interference, and the system configuration has been reviewed to isolate subsystem components that have been identified as contributing to the interference difficulties.

The Jackson, Mississippi, Police Department is approximately 225 miles from Montgomery, Alabama, and is authorized to use the six VHF channels listed below from a single location at 2320 Riverside Drive. The transmitter power and antenna height being used on the main dispatch base station channel is also shown below.

<u>Frequency</u>	<u>Input Power Used</u>	<u>Antenna Height</u>
154.740 MHz	200 watts	210 feet
154.830 MHz	(Mobiles)	--
155.070 MHz	275 watts	242 feet
155.415 MHz	275 watts	185 feet
155.490 MHz	(Portables)	--
159.090 MHz	(Motorcycles)	--

The base stations are operated in the single-frequency simplex mode.

The Atlanta, Georgia, Police Department is approximately 175 miles from Montgomery, Alabama, and is authorized to operate on VHF Band Channel of 155.625 MHz which is common to the Montgomery, Alabama, authorization. This channel is used in a mobile relay mode continually by approximately 95 detective cars and 135 portables operating in Atlanta. Future plans are to add 35 additional airport police units to this channel. This channel is also used as a backup dispatch channel for 155.700 MHz. The base station operates at approximately 175 watts input power and uses a 6-dB omnidirectional antenna. The antenna is located approximately 255 feet above the earth. A tower mounted on a building near the Police Station is used as a support for this antenna.

### 3.2 Interference

The Montgomery, Alabama, Police Department is licensed to operate their radio system on two VHF frequencies (155.415 and 155.625 MHz) that are common to those frequencies in use in Jackson, Mississippi, and Atlanta, Georgia. The Jackson, Mississippi, Police Department uses 155.415 MHz as one of their main dispatch channels. The Atlanta, Georgia, Police Department uses 155.625 MHz in a mobile relay mode for coverage to detective cars and several portables working in a section of Atlanta. Several other Georgia Police and Sheriff Departments at various distances from Montgomery have frequencies that are common to all of those in use in Montgomery, Alabama (i.e., Berrien County Sheriff -- 155.190 MHz, Berrien City -- 155.520 MHz, etc.). A detailed list of all Georgia on-channel

users was obtained from the State Office of Telecommunications in Atlanta and is included in Appendix A for reference. Because of the distance between the stations having common frequencies (Montgomery, Alabama; Jackson, Mississippi; and Atlanta, Georgia), the topographical features in the area, the antenna heights and locations, the receiver sensitivities, and the operating power of the stations, it is reasonable to expect that sporadic communications interference on channel would be experienced. Depending upon the propagation conditions that exist, observed signal strengths could be strong enough to produce destructive-type interference on the Montgomery police frequencies.

VHF radio waves normally travel in straight lines; however, conditions can exist that cause them to do otherwise. Because of this straight-line (line-of-sight) propagation, VHF communications tend to be local in characteristic covering only slightly more than line-of-sight distances. Although this type of communications is the normal planned usage for VHF systems, there are many ways by which the VHF wave energy can be reflected, refracted, or scattered allowing communications to take place at distances greater than line-of-sight. Because of this, the FCC Rules and Regulations, Part 89, Public Safety Radio Services, require that an analysis of probable interference be performed for all stations operating on the same channel within a 75-mile radius before an authorization to use the frequency will be made. This requirement results directly from the known potential on-channel interference that can be caused by nearby stations; however, under many circumstances interference from distances greatly exceeding the 75 mile range can be experienced. Antenna height and gain, transmitter power, receiver sensitivity, and atmospheric conditions influence the distance at which interference can take place.

Systems designed to cover a local area normally have antenna heights that are sufficient to permit reliable (in many cases line-of-sight) communications. Antennas are placed high enough to minimize the effects of terrain masking. Although they are often thought of as permitting only straight-line communications, VHF communications systems have been observed to work well in both open country and in mountainous terrain. They have been used for communications even when ridges lie in the direct path between stations. It is not uncommon to assume that terrain in a given situation will adversely affect communication and then to conduct field measurements of this situation and find that communications are possible. A mountain ridge can be assumed to block a communication path but will not do so under all conditions. Knife-edge diffraction and reflections over and around mountains are common at VHF. The best predictions of coverage that can be obtained results from field measurements of system performance, and even this cannot account for sporadic conditions that can cause interference. At best, the communications engineer must account for the likely interference conditions and accept the fact that some long-range interference is possible.

Normally a system design is established to provide reliable local communications between the base stations and the mobile and portable units in an area. This design takes into account local topographic features and typical communications conditions for the area to be served. The system is designed to comply with FCC regulations and does not always account for sporadic long-distance communications that may be experienced. Unfortunately, in the VHF frequency ranges used in Public Safety Radio Systems, long-distance communications very often beyond the planned range for reliable system performance can be achieved. This is a common occurrence and appears to be the situation that exists for the on-channel interference that is being experienced in Montgomery, Alabama.

Long range on-channel interference can be of both the nuisance and destructive type. Nuisance interference results when the on-channel interference is relatively weak compared to the desired signals and can often be eliminated by adding coded squelch to the radio system. (The Montgomery Police Department does not have coded squelch on their present equipment.) Destructive interference results from undesired signals on the same channel which are sufficiently strong to garble or override the desired signal. In this type of interference, the interfering signal cannot be eliminated by a tone coded squelch system because it is of sufficient magnitude to mask the desired signal.

Reports obtained from the Montgomery Police Department personnel indicate that both nuisance and destructive type interference is heard from stations normally beyond the desired coverage range. Several of these stations (Jackson, Mississippi; Atlanta, Georgia; Berrien County Sheriff's Department, Georgia) have been identified by individuals who are closely associated with the Police Department's communications system. The fact that both nuisance and destructive type interference is present at varying times from the same on-channel interfering stations indicates that interference is significantly influenced by the propagation conditions. Under these circumstances only those changes that can reduce the probability of communications between Jackson, Atlanta, and Montgomery can reduce or eliminate this type of interference.

The Consultant visited the Montgomery Police Department several times during the two days spent in Montgomery and no sporadic interference was observed by the Consultant during these brief observations. Several discussions were held with dispatchers and many police officers who described the problems they were experiencing. These descriptions from the officers were complemented by the more technical descriptions provided by the Montgomery radio engineer and members of the CTAC.

The City of Montgomery has a great deal of radio activity in the VHF range. Several antennas are within line-of-sight of the Police Department, including one very large commercial television tower. It is very

common for nearby radio signals to create frequencies that cause interference. Interference produced from nearby users can come from spurious emissions, harmonics, subcarriers, and intermodulation products and are generally difficult to identify and eliminate. The number of VHF users in the immediate area of the Montgomery Police Department suggests a potential interference environment.

A mathematical analysis can often be useful in identifying potential sources of local interference; however, field measurements are usually required to isolate the source of difficulty. Because of the number of VHF stations in the immediate area and the reports of interference from local stations (paging services, hospitals, ambulance services, etc.) a brief mathematical analysis was made to determine potential interference that could result from intermodulation. A list of 23 VHF channels in use within approximately one mile of the police station was used in this analysis. Table 3-1, Nearby VHF Users, lists these frequencies. The third-order and fifth-order difference products were considered, and both on-channel products and products falling on nearby frequencies within  $\pm 15$  kHz of the channel were identified as potential interference sources. Table 3-2, Intermodulation Analysis Summary, lists some of the third- and fifth-order intermodulation products that can be created by the 23 frequencies considered. The users of these frequencies are identified on this figure by an identification number that corresponds to those shown on Figure 3-1. For example, an on-channel third order intermodulation product exists on 155.190 MHz. The users 16 (Jackson Hospital) and 18 (Montgomery Police Department) can be found by referring to Table 3-1.

This intermodulation product analysis verified some of the local interference descriptions that were received from several members of the Montgomery Police Department. This analysis showed that the six intermodulation products falling on the police channels can be created by nearby users and that 14 off-channel (within  $\pm 15$  kHz) products falling very close to the Montgomery police channels are also created. These intermodulation products create a strong possibility for interference on the police communications channels. This type of interference is generally a very sporadic type that is difficult to both identify and eliminate.

A brief discussion was also held with the local and regional representatives of General Electric, suppliers of the Montgomery Police Department base stations, to review the VHF interference potential that existed in the immediate area of the Montgomery Police Department. The discussions indicated that the local General Electric service personnel are very concerned with the number of VHF users in the area and have spent time in analyzing, reducing, and eliminating interference resulting from the intermodulation in several systems. They were unaware of the detailed difficulties being experienced by the Montgomery Police Department, but at their service center location relatively near the Police

TABLE 3-1

## Nearby VHF Users

<u>Identification Number</u>	<u>Frequency (MHz)</u>	<u>Assigned User</u>
1	151.055	State Highway Department
2	151.685	Rutherford's TV Service
3	152.240	Montgomery Telepage
4	152.330	Red Taxi Company
5	152.630	Mobile Telephone
6	152.660	Mobile Telephone
7	152.750	Mobile Telephone
8	152.840	Telephone Paging Service
9	153.410	Water Works
10	154.385	Fire Department
11	154.430	Fire Department
12	155.010	Police Department
13	155.160	Ambulance Company
14	155.190	Police Department
15	155.220	Ambulance Company
16	155.355	Jackson Hospital
17	155.415	Police Department
18	155.520	Police Department
19	155.625	Police Department
20	158.100	Telephone Paging Service
21	158.700	Montgomery Telepage
22	159.450	Conservation Department
23	163.200	U.S. Marshall

TABLE 3-2

Intermodulation Analysis Summary

Montgomery, Alabama, Police Frequency (MHz)	On-Channel				Off-Channel (Within ± 15 kHz)			
	Third Order Frequency (MHz)	User I.D.	Fifth Order Frequency (MHz)	User I.D.	Third Order Frequency (MHz)	User I.D.	Fifth Order Frequency (MHz)	User I.D.
155.010	None		None		155.020 155.025 155.025	10, 7 14,16 15,17	155.025	16,18
155.190	155.190	16,18	None		155.205	17,19	155.205	17,18
155.415	155.415	18,19	None		155.430	15,12	155.400	20,22
155.520	155.520	16,14	155.520	11,10	155.530	10, 3	155.535	17,16
155.625	155.625	18,17	155.625	16,15	155.635 155.640 155.610	12,10 17,14 17,15	155.640	15,12

Department have experienced similar interference resulting from inter-modulation (not necessarily on the Montgomery Police frequencies but on VHF channels in use in the area).

A complete analysis of adjacent channel interference sources was not performed; however, it is quite common for signals falling near the main operating frequency to be so strong that they are not rejected by the receiver selectivity. The FCC Rules and Regulations Part 89 specifies the detailed adjacent channel criteria that must be met when frequency assignments are made. Where practical, these adjacent channel criteria are adhered to by frequency coordinators; however, recommendations for operation on adjacent channels have been made in areas where no alternative to frequency assignments exist. Three of the Montgomery Police frequencies (155.415, 155.520 and 155.625) have other police users on both adjacent channels; 155.010 is bounded by local government users, and 155.190 is bounded by Special Emergency Radio Service Channels. The frequency coordinators for each of the services involved can identify any potential problems that may be created by adjacent channel assignments. Generally, the assignment of nearby users on adjacent channels is avoided by all coordinators. The intermodulation analysis performed by the Consultant showed that some frequencies falling close to the Montgomery police channels can be generated by nearby VHF radio stations and may be a source of adjacent-channel-type interference difficulties. Although the possibility for adjacent-channel-type interference exists, it generally is not a major problem because of the efforts of frequency coordination in assigning frequencies and the inherent ability of the equipment to reject off-channel interference.

### 3.3 Coverage

Discussion with the Montgomery Police Department indicated that they experienced areas in their jurisdiction where car-to-car communications could not be achieved. It was reported that there are occasions when several cars would attempt to transmit at the same time resulting in destructive type interference being experienced at the dispatch center. Since the communications system in use by Montgomery is operating in a single-frequency simplex mode, extended range car-to-car coverage should not be expected. Because of the low antenna heights, environmental noise, and lower power used by mobile radios, reliable car-to-car coverage, usually be obtained for only a few miles at VHF. The area of Montgomery is such that cars operating at different points in the city can be sufficiently far apart to be beyond the range for reliable communications coverage. In addition, terrain masking resulting from the types of elevation changes observed in Montgomery can very often eliminate the ability for two cars to maintain reliable single-frequency simplex communications. A mobile relay configuration is the only way to achieve consistent car-to-car coverage over an area as large as that served by the Montgomery Police Department.

#### 3.4 Potential System Improvements

Based on the observations made by the Consultant it is not felt that any single change will result in interference-free operation of the Montgomery Police Department communications system. Although interference was not observed during the brief visits to the police station, the descriptions received from several system users indicated that it is both the nuisance and the destructive type. The brief analysis performed indicates that it is caused by both on-channel stations and possibly by on-channel and adjacent-channel frequencies generated by intermodulation. Generally, the technique to reduce or eliminate interference is to make changes that reduce the magnitude of the interfering signal either at the source of the signal (not practical for on-channel users such as Jackson, Mississippi; and Atlanta, Georgia) or at the receiving end.

Table 3-3, System Improvement, identifies near-term changes that may offer improvement to the Montgomery Police communications and indicates the expected results from making the changes. It can be readily seen that the suggested changes are interactive such that improvements resulting from changes in one area may offer other disadvantages. These suggestions should be reviewed in relation to the changes that have already been made. Combinations of changes (such as both reducing the receiver antenna height and decreasing the receiver sensitivity) should also be explored.

This set of suggestions is not exhaustive but represents the type of improvements that can be made. The in-state expertise (radio engineers, CTAC, etc.) may have tried all of these approaches and perhaps others; however, this should be established before major system changes, such as replacing equipments, are made. In the long run, the most desirable and perhaps most cost-effective solution could be a change to a newer UHF system.

A qualitative estimate of showing the general cost and time relationships for the suggested investigations and improvements is shown in Figure 3-1, Generalized Cost Time Relationships. This represents a first-cut estimated picture of the situation that exists. Detailed cost estimates and schedules should be prepared for the various alternatives. These detailed estimates may differ from those shown in Figure 3-1.

Table 3-3

System Improvements

<u>Suggested Changes/Actions</u>	<u>Expected Results</u>
1. Lower the height of the receiving antenna on the Montgomery Police Communications Tower near the Police Station.	A lower antenna should reduce the probability of receiving long-distance sporadic interference from Jackson, Mississippi, and Atlanta, Georgia. This is also likely to reduce the coverage in the Montgomery area; however, a compromise height could be achieved.
2. Add bandpass filters to the Montgomery Police receiver that pass the frequencies of interest and attenuate others which are potential sources of intermodulation.	If the intermodulation is being generated at the receiver, appropriate filters can reduce or eliminate this source of interference. The investigation of appropriate points and frequencies to filter must be accompanied by field tests.
3. Reduce the sensitivity of the Montgomery Police Department's receiver.	A reduction in sensitivity could be accompanied with a reduction in the ability to communicate with Police Department personnel. It will reduce both the on-channel desired signals as well as all other signals that could be causing interference.
4. Change the location of the transmitter and receiver antennas.	The present antenna site is ideal in that it is close to the station and at a reasonably high elevation thus offering good coverage potential. Unfortunately, several other VHF stations operate in the immediate area thus causing potential interference problems. A change in antenna site must be accompanied by field tests to ensure that coverage is maintained and interference is reduced.

Suggested Changes/Actions

Expected Results

- |   |  |
|---|--|
| 5. Add directive elements to the receiver antenna to reduce long-distance on-channel interference.                      | Long-term plans of the Jackson, Mississippi, Police Department show a change to a UHF system. Since on-channel interference from this direction will be reduced by this change, a directive element or directive antenna could reduce the magnitude of the signals being received from the Atlanta direction. A change in the antenna directivity also changes the local coverage pattern; therefore, tests would have to be made to ensure adequate local performance was being achieved.               |
| 6. Change the operating frequencies of the Montgomery Police Department.  | This would require a complete re-crystallizing of all equipments involved and a license change. A complete analysis and tests must be made to ensure that any new frequencies selected do not create new interference difficulties.  |
| 7. Add tone-encoding equipment to the present system.   | This would eliminate most nuisance type interference but leave the destructive type interference unchanged. The feasibility of doing this needs to be explored with the equipment supplier(s). Tone frequencies must also be coordinated with other users.   |
| 8. Conduct detailed tests to identify the sources of intermodulation and where they are entering the Montgomery system. | A great deal of this analysis and testing has already been accomplished; however, a review of the actions taken should be made to ensure that all readily available alternatives have been explored. Once the sources of the signals are identified and the points where the problems are being generated become known, it is sometimes possible to add filters that reduce this type of interference. Coordination with the equipment supplier is required in adding filters to the existing equipment. |

Suggested Changes/Actions

Expected Results

- |  |   |
|--|---|
| 9. Convert the present VHF system to a mobile repeater mode, along with appropriate change in operating frequencies. | This is a major system change that requires a feasibility and cost analysis. Much of the interference will be eliminated by this change and the car-to-car coverage problem should be resolved. A license change would also be required to allow operation in this mode.  |
| 10. Replace the existing system with an up-to-date UHF system operating in a mobile repeater mode.                   | This is a major system change that requires a complete analysis to ensure that interference problems will be avoided. Although there is little UHF operation in Montgomery at this time, it is reasonable to expect that operations in this band will increase in the future. UHF channels must also be carefully coordinated to avoid intermodulation. |

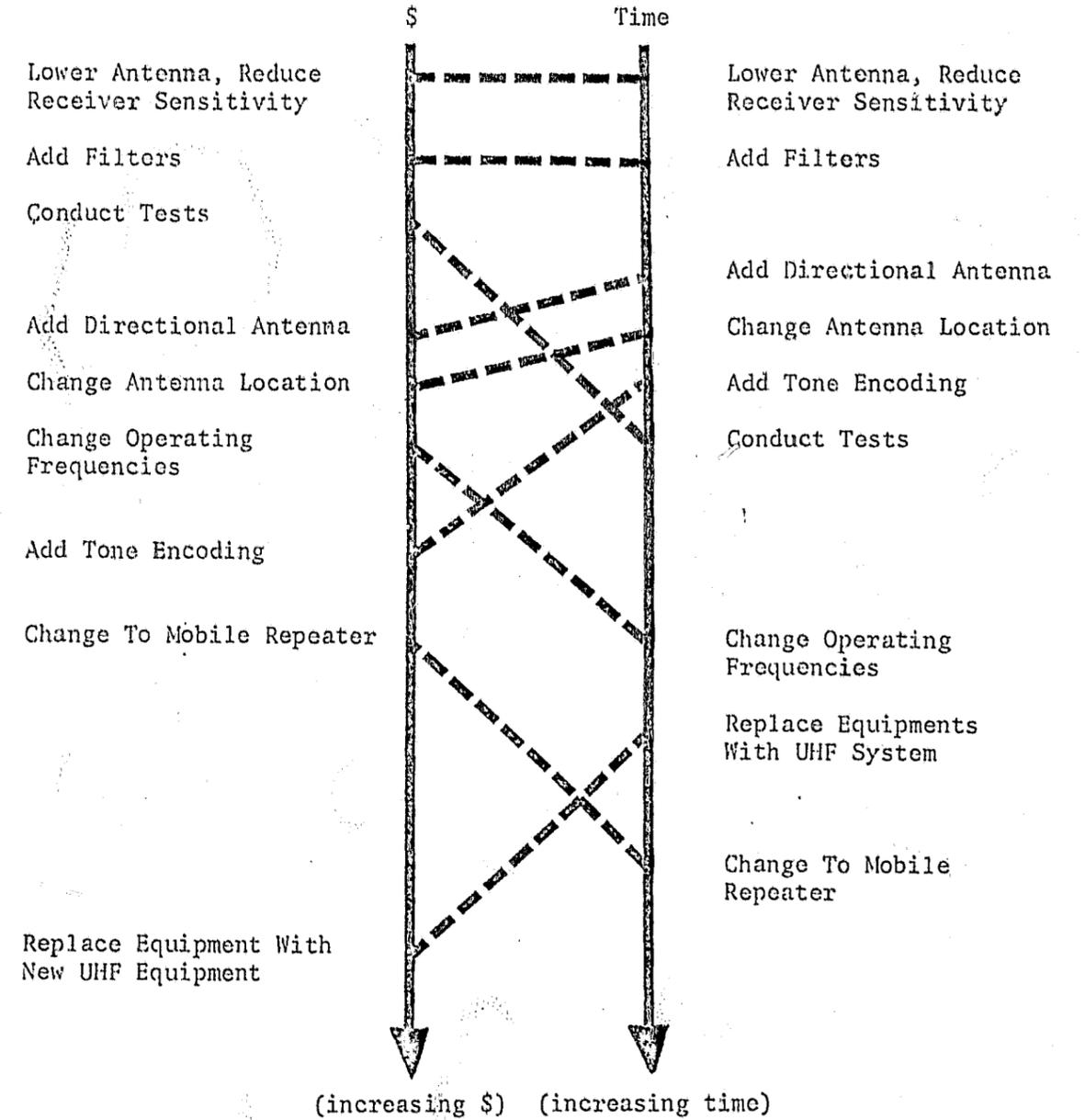


Figure 3-1. Generalized Cost/Time Relationships

4. FINDINGS AND CONCLUSIONS

- (a) The Montgomery, Alabama, Police Communications System experiences both interference and car-to-car coverage problems that result from the system configuration and its operation in a high density VHF radio usage area.

The analysis, which was performed by the Consultant, included a configuration review and a prediction of operational characteristics that were likely to be experienced. It verified reports that were obtained from both system users and several individuals who were closely associated with the system. A detailed engineering assessment of all of the changes that have been made to improve system performance could not be accomplished in the period covered by the technical assistance; however, discussions with the Supervisor of Communications for the City of Montgomery showed that a number of changes have been made to reduce the interference and improve car-to-car communications. These changes and those that may be made in the future are not likely to eliminate all of the problems that are presently being experienced unless major system configurational changes are made.

- (b) The solution to the Montgomery Police Communication difficulties consists of both near-term improvements and longer range major configuration changes.

A number of changes are possible to improve the situation that exists. Some of these changes have been tried and others have been suggested by this technical assistance. Each of the changes has associated with it a dollar cost that must be considered in relation to the long-range system plans and the resources available. Considering the age of the Montgomery Police Communications System and the potential improvements that can be achieved by making a major system change such as going to a UHF mobile repeater configuration, a detailed financial prediction of all costs for changes is required to ensure that resources are properly allocated to system improvements. Any near-term improvements that represent a large financial

investment should be carefully analyzed to ensure that the degree of improvement justifies the expenditure.

- (c) A complete detailed analysis of the VHF usage in the Montgomery area and the available VHF police frequencies should be made before any changes to a UHF system are made.

Part 89 of the FCC Rules and Regulations defines 66 VHF High Band channels that can be allocated for Police Department use. A number of restrictions and conditions are attached to these frequencies, and these are considered in detail by the frequency coordinators. In addition some frequencies may not be desirable as they require special equipment characteristics such as wide-spaced transmitters or receivers. Presently the VHF usage in Montgomery creates several situations that are potential sources for creating intermodulation on the assigned police channels. The long-distance interference caused by both Jackson, Mississippi, and Atlanta, Georgia, results from their operation on the same frequency as the Montgomery Police Department. Perhaps a different VHF High Band frequency allocation could be made for the Montgomery Police Department operations. It should be noted that any frequency change would require a license change and also equipment changes to permit operation on new channels.

- (d) The long-distance interference from Jackson, Mississippi, will be eliminated in the future and the long-distance interference from Atlanta, Georgia, will get worse in the future.

Discussion with several individuals in Jackson, Mississippi, indicated that they presently have plans to change their communications system from the VHF Band to the UHF Band. These changes will represent a gradual change over in perhaps a year or two and are dependent upon the availability of resources to permit Jackson to implement their plans. If plans are implemented, all Jackson police operations will be moved to UHF and thus eliminate their interference with Montgomery. On the other

hand, Atlanta, Georgia, has plans to add additional units to the channel that is presently interfering with Montgomery. This will increase the activity on this channel and, under appropriate propagation conditions, increase the interference experience by Montgomery.

- (e) A change to UHF could also create a set of problems similar to those presently being experienced.

The UHF Band is not likely to permit sporadic long distance skip communications that can cause destructive interference; however, it can produce reliable communication links over long distances if the proper combinations of power, antenna heights, and receiver sensitivities are achieved. A careful analysis of on-channel users is necessary to ensure that this type of interference can be avoided. In addition intermodulation can also be experienced at UHF; therefore, a review of the UHF users in the area of the police communications equipment must be made. UHF users are likely to increase in the future and this should be considered in developing the system plans. Although tone squelch can eliminate nuisance-type interference, strong destructive-type interference is left unaffected. Any new frequency allocations in the UHF range should be reviewed to ensure that a minimum of difficulties will be encountered by operation on the new frequencies.

5. RECOMMENDATIONS

- (a) Establish a meeting between the State Office of Telecommunications, the Communications Technical Advisory Committee, the Supervisor of Communications for the City of Montgomery, and the ALEPA Communications Specialists to review the detailed changes that have already been made to the Montgomery system, to establish immediate actions that are required to improve the situation, and to determine the detailed cost/performance impact of all near-term and long-term improvements.

The Supervisor of Communications for the City of Montgomery has carefully analyzed the problems being experienced in Montgomery and has made several changes to improve performance (changing antenna locations, desensitizing receiver, filtering, etc.). A detailed summary of these changes should be prepared and reviewed to ensure that all possible individual changes and combination of changes have been tried. All available in-state expertise should participate in this review to ensure that all feasible approaches have been explored. This meeting should also include a review of the VHF usage in the Montgomery area. As a result of this review, the meeting participants should prepare a plan of action for implementing new changes and follow the implementation of these changes to ensure that the expected results are achieved.

- (b) Prepare a detailed cost estimate and schedule for changing the Montgomery VHF system to a new UHF mobile repeater configuration.

Discussions with several individuals associated with the Montgomery Police Communications System indicated that a change to UHF would resolve many of the difficulties presently being experienced in Montgomery. This is likely to occur, provided a proper UHF system design and frequency allocation is made. The costs for this major change should be reviewed in detail to determine the resources required to implement the changes.

- (c) Review all future communications equipment purchase specifications to ensure that the desired performance requirements are being presented to the candidate equipment suppliers.

During the course of the technical assistance, the Consultant had a very brief exposure to some communications equipment specifications that were prepared. Although the detailed circumstances surrounding these specifications were not explored, it was noted that some of these specifications included detailed equipment model numbers. In some situations, this type of detail in a specification ensures that the buyer will get the equipment desired; however, for major procurements it is generally better practice to outline performance requirements and allow the suppliers to decide for themselves the detailed equipment model numbers that can meet these requirements. Any specifications developed for a significant purchase of equipments (such as those for a change to UHF) should follow the performance requirements specification approach.

APPENDIX A

Authorized and Planned Georgia Users  
Common to Montgomery, Alabama, Frequencies

155.010 MHz

Albany Police Department  
Bainbridge City  
Cairo City  
Calhoun Police Department  
Camilla Police Department  
Colquitt Sheriff's Department  
Cartersville City  
Doerun Police Department  
Gordon County  
Grady County  
Lauren County  
Michell County Sheriff's Department  
Moultrie City  
Pavo Police Department  
Pelham Police Department  
Thomas County Sheriff's Department  
Thomasville Police Department  
Trennil Hill Police Department  
Taylorsville Police Department

155.520 MHz

Athens Police Department  
Bremen City  
Buchannen Police Department  
Carnesville Police Department  
Cedartown Police Department  
Dallas Police Department  
Douglas County Sheriff's Department  
Douglasville City  
Haralson County Sheriff's Department  
Lavonia City  
Paulding County  
Polk County Sheriff's Department  
Polk County Police Department  
Rockmart Police Department  
Royston Police Department  
Tallapoosa Police Department  
Tallapoosa Judicial Circuit D.A. Department  
Stephens County Sheriff's Department  
Hart County Sheriff's Department  
Franklin County Sheriff's Department  
Banks County Sheriff's Department  
Hartwell Police Department  
Hiron City Police Department  
Lawrenceville City  
Jeffersonville City

155.415 MHz

Fulton County Sheriff's Department  
Glennville Police Department  
Houston County Commissioner's Office  
Lutherville Police Department  
Manchester Police Department  
Meriwether County Sheriff's Department  
Talbot County Sheriff's Department  
Talbotton Police Department  
Vidalia Police Department  
Warm Springs Police Department  
Woodbury City  
Woodland Police Department

155.190 MHz

Adel Police Department  
Auburn City  
Barnesville City  
Berrien County Sheriff's Department  
Chattahoochee County Sheriff's Department  
Clay County Sheriff's Department  
Cook County  
Cusseta Police Department  
Richland City  
Shellman City  
Sparks Police Department  
Stewart County Sheriff's Department  
Tifton Police Department  
Tift County  
Waynesboro City  
Nashville City  
Cuthbert City  
Fort Gaines Police Department  
Lanier County Sheriff's Department  
Lenon Police Department  
Louisville Police Department  
Lumpkin Police Department  
Randolph County  
Georgetown Police Department

155.625 MHz

Atkinson County Sheriff's Department  
Atlanta Police Department  
Ben Hill County Sheriff's Department  
Coffee County Sheriff's Department  
Douglas Police Department  
Ellijay Police Department  
Fannin County Sheriff's Department  
Fitzgerald Police Department  
Gilmer County Sheriff's Department  
Harlem Police Department

155.625 MHz  
(continued)

Irwin County Sheriff's Department  
McCaysville Police Department  
Pearson Police Department  
Ocilla Police Department  
Willacoochee Police Department  
Broxton City Police Department  
Nicholls Police Department  
Blue Ridge Police Department

**END**