LAW ENFORCEMENT ASSISTANCE ADMINISTRATION (LEAA)

POLICE TECHNICAL ASSISTANCE REPORT

SUBJECT: Police Communications Assessment

REPORT NUMBER: 77-082-170

FOR: Tempe, Arizona, Police Department

Population	103,000
Police Strength	
(Sworn)	131
(Civilian)	41
Total	172
Square Mile Area	36.3

CONTRACTOR: Public Administration Service
1776 Massachusetts Avenue, N. W.
Washington, D. C. 20036

CONSULTANT: R. James Evans

CONTRACT NUMBER: J-LEAA-002-76

DATE: December 6, 1977

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EXHIBITS

I. INTRODUCTION

This report was prepared in response to a request for technical assistance from the Tempe, Arizona, Police Department in the form of an assessment of their communications equipment. The department specifically asked that the consultant determine 1) whether the current equipment should be repaired or replaced, 2) whether this equipment, even if repaired, could accommodate future needs, and 3) if the current equipment should be replaced, when should that replacement be accomplished. The consultant assigned was Mr. R. James Evans, and those involved in processing the request included:

Requesting Agency:	Captain Terry Stewart Administrative Division Tempe Police Department
State Planning Agency:	Mr. Robert E. Hitchcock Police Specialist Arizona State Justice Planning Agency
Approving Agency:	Mr. Robert O. Heck Police Specialist LEAA Office of Regional Operations

Background

Tempe is located on the outskirts of Phoenix, Arizona, and is experiencing a rapid population growth. In 1960, the city covered an area of 17.5 square miles and a population of 24,897; 10 years later, it had grown to 23.3 square miles and 68,755 people; as of 1977, the population is estimated at 103,000, living in a 36.3 square mile area. With 750 people per month moving into the city, a 1987 population of 190,000 has been predicted, with a maximum potential of 225,000. Since the police department must expand by a similar ratio, the department is well aware that its communications facilities must be continuously updated in order to provide fast and reliable police service.

Priorities

In requesting technical assistance, the priority items in the radio control room were listed as follows: communications control console, vehicle status display map, tape logger recorder, standby repeater, personnel paging system, random access projector, and alarm panel. In addition to these items, Chief of Police Arthur Fairbanks asked the consultant to review the existing radio frequencies to determine if they were adequate for future departmental radio expansion, to make a recommendation as to the replacement of all base station, mobile, and portable radio units, and to review the radio technician's workload in order to determine if additional personnel were required in this area.

Methodology

In order to meet the technical requirements of the task, it was necessary to carry out an in-depth review of the various radio control

room equipment and functions listed as priorities. During the on-site phase of the assignment, November 7-11, 1977, control room functions were observed over a period of several hours during the day and evening shifts, and the consultant discussed performance and failures experienced with the items used during a dispatcher's shift. Also, a recently installed satellite receiver system located on the south side of the city was inspected.

A number of hours were spent with radio technician Stan Conners regarding the existing equipment and frequency problems. The fact that Mr. Conners was recently appointed to the State of Arizona Public Safety Frequency Committee will provide the department with direct contact relative to any frequency problems. Mr. Conners has been with the department approximately one year; before that, the department depended on a contract with a local radio maintenance firm.

To assist in providing a consistent equipment review covering all items, the consultant prepared a work sheet to be used as an evaluation guide (see Figure 1, a sample evaluation sheet).

After all data had been collected, the consultant met with Mr. Sam McCartt of the General Electric Company to determine trade-in values of old equipment and the cost of new replacement items.

As part of the assessment of radio frequency problems, the consultant also met with the chairman of the State Frequency Committee, Mr. Jim Wortham, to determine what frequencies would be available for future expansion. He provided the consultant with a copy of the state frequency manual listing all FCC licensees, excepts from which showing the police assignments are included as Appendix A to this report.

Personnel interviewed during the on-site visit included the following:

Chief Arthur Fairbanks
Tempe Police Department

Captain Terry Stewart
Tempe Police Department

Captain Richard Christensen
Tempe Police Department

Mr. John W. Greco
Director of Planning and Development
Tempe Police Department

Mr. Stan Conners
Radio Technician
Tempe Police Department

Mr. Jim Wortham
Frequency Coordinator
State of Arizona

Mr. Sam T. McCartt
General Electric Company

FIGURE 1
Sample evaluation sheet.

EQUIPMENT EVALUATION AND SURVEY

EQUIPMENT TYPE AND INFO.	NO. UNITS	AGE	TRADE IN VALUE OR REPLACE-MENT COST	CONVERSION		MAINTENANCE RECORDS	DAILY USE CONSTANT? 8 HR. 24 HR. OCCASIONAL	OTHER FUTURE EXPANSION AND ETC.
				NEW FREQ.	NEW CONCEPTS			

II. ANALYSIS OF THE PROBLEM

The primary objectives of this assignment were to review radio control room equipment items and to determine if they should be repaired or replaced, and if the latter, when? If they were repaired, would the radio control consoles be adaptable to future expansion and improvements?

A secondary objective was to determine if the present two VHF radio frequencies were adequate for police expansion and operation over the next five years.

The Chief of Police asked for a five-year program of communications revision that will provide: 1) reliable communications operation, 2) an expansion capability, and 3) reduced technical breakdowns of equipment.

An internal problem exists in the dispatcher area, where there is an ever-increasing manual workload that could be considerably reduced and overall operations improved by control room automation.

There is also a technical problem that centers around the control consoles in the dispatch office. Many modifications have been made in the equipment over the past five years, apparently without any work diagrams or instructional changes. This has made it next to impossible to make quick repairs and has resulted in long out-of-service periods during equipment failures. This technical problem has surfaced since the department hired a qualified radio technician to maintain all of its electronic equipment. Prior to the use of a full-time police technician, the department contracted for the services of a local electronic maintenance firm. Preventative maintenance on the equipment for this period apparently was not part of the contract; consequently, the equipment was not maintained to factory specifications. Many electronic additions to the equipment during the past five years were made with parts or assemblies not from the original equipment manufacturer, and this is now creating a replacement and servicing problem.

Primary Problem Areas

The consultant, with the aid of departmental personnel, first sought to evaluate the radio control room equipment and its operations.

The control room contains two consoles that were purchased and installed in 1972 and that will soon be six years old. The normal life of this type of equipment is seven to ten years, based upon a number of factors, some of which are: 1) Daily use, i.e., 8 hr., 16 hr., or 24 hr., 2) quality of maintenance; 3) need for expansion of frequencies; and 4) addition of new concepts (updating).

The existing consoles have had many modifications in the wiring area that apparently were made without documentation or schematics for future maintenance. The entire console wiring is very complicated and in poor condition. This creates out-of-service periods of long duration which can result in severe or critical problems for the officers in the field and for the public, which frequently requires immediate police action.

Several specific problem areas were observed, such as intermittent switch contacts that are required to switch the operator's headset from radio to telephone. Repairs have been attempted; however, frequent failures continue. Another problem area involves lack of adequate switching on the No. 2 console for the car status indicators. This problem developed when the second frequency was installed and both operators become responsible for the car status in their city operating area. Parts such as relays have been added to the console for additional channel use and are lying loose upon existing layers of wire and parts, thus creating a fire hazard and service problem.

During the consultant's observations of the radio operating procedures, it became apparent that each operator when receiving a call has many manual functions. These include keeping a running radio log, looking up warrant information in a manual file, operating the state and federal computer terminal, answering the telephone, monitoring channel 9 on a CB set, maintaining the status of all vehicles in operation, paging off-duty police personnel when required, handling calls for public works vehicles on the weekends or during the night if urgent needs arise, answering alarms from business places, and numerous other duties.

Several devices have been added in an attempt to alleviate this operator overloading, one of which is the magic-call telephone dialer that automatically dials a number of pre-recorded often-used telephone numbers.

The second area of concern is the vehicle status display which was mentioned as one of the operator's function. The control is only available from one console position, making it necessary for the second operator to manually record the status of each vehicle many times during an hour of operation. The status lamps on the display are of the high current type and have a very short life, thereby creating an extra maintenance problem. The cabling from the console to the status map is in bad condition. The car status information should be stored in a mini-computer where it could be entered from a keyboard and retrieved momentarily, as required. One improved method that should be considered is to have cathode ray tube (CRT) connected to a mini-computer for car status only; this would automatically update each time the operator enters a change.

The third area of concern is the logging tape recorder. This equipment appears to be in good condition and has a 30- to 40-channel recording capability, which is deemed adequate for the next five-year period.

The fourth area is the standby repeater base station. This unit is only used during emergencies when the main repeater station fails. The equipment should not require immediate replacement; however, the 110 volt AC wiring and circuits should be updated and a separate power circuit supplied for the unit. If a frequency change is made to the UHF band, it will be necessary to replace the standby equipment.

The fifth area concerns the paging system. Presently this operates one the No. 1 radio channel. The system has three pocket paging units

for use by officers when on call. The base station should not be considered for replacement at this time, since it performs a dual duty. If a new frequency is obtained for the mobile and portable system, then it would appear reasonable to keep the existing VHF base station for the paging operation. The pocket pager units should be replaced in the near future, since they are not reliable and require considerable maintenancce.

The sixth area of concern is the random access projector. This unit has not operated satisfactorily and probably should be traded in on a newer version using prerecorded microfilm. The radio operators indicated an occasional requirement for high-resolution and detailed street mapping areas.

The seventh area is the alarm panel. This equipment and the associated remote relay panel are obsolete and require considerable maintenance. The relays appear to be an army surplus type, not available on today's electronic market. The wiring at the console terminal is in exceptionally poor condition. The complete alarm system should be updated at the same time the radio control consoles are replaced.

Secondary Program Areas

A major secondary problem area concerns the radio frequencies, specifically whether the existing VHF frequencies will suffice for future expansion or whether the entire police system should be moved to a new UHF set of frequencies. This problem must be resolved prior to any long-range planning or replacement of base station, mobile, or portable equipment.

The police department has recently added a second VHF radio channel and an extensive satellite receiver system. The second radio frequency is only 15 KHz removed from one assigned to the Scottsdale, Arizona, Police Department. The close proxinity of the two frequencies is creating interference for cars and portable units when within two miles of the Tempe base station repeater.

Radio tests were conducted prior to FCC licensing between the two cities, and no interference was noted. Since the installation was completed, corrections of a technical nature have been made without success in removing the problem.

The consultant, in attempting to find a solution to this problem, contacted the state frequency coordinator to ascertain if any VHF channel was available for assignment in the area. The coordinator advised that all interference-free channels in the area were presently assigned.

At this point a meeting was held with the state coordinator to review the UHF police radio frequencies in an effort to find a solution to the problem. All 20 pairs of these police channels were assigned in the area. The UHF local government channels were reviewed, but no assignments were available in this band. Portions of the State of Arizona frequency manual covering the requested assignments are attached as Appendix A.

An inquiry was made regarding the use of the TV shared channels, (470 to 512 MHz), and the frequency coordinator stated that channels were available in the area, but that none had been assigned. (These channels may have some future TV interference problems.) The next available band is at 800 MHz, and one station is now operating in Phoenix on this band in a base and mobile configuration.

In view of the channel situation, the Tempe Police Department should attempt to obtain three pairs of these channels for their future operation and start a dual use of VHF and UHF until funds are available to complete the changeover. A change from the existing VHF radio frequencies to the 800 MHz band requires replacing all transmitting and receiving equipment in base stations, mobiles, and portables. The change to 800 MHz will eliminate the interference with Scottsdale police units and will provide necessary future system expansion.

Since the frequency problem is a critical requirement, the Tempe Police Department should immediately proceed to obtain the necessary FCC license, then purchase one radio repeater base station and a few field units. These would be used in a hybrid type of operation until the complete system is changed over. It is estimated that total system replacement may exceed $300,000 in cost and may take up to 5 years. (See Figure 2, a five-year time frame.) The only reason for a hybrid type of operation on the two bands of VHF and 800 MHz is the lack of funds to completely change in one budget year. If funds were available it would be more desirable, technically and operationally, to change the entire system at one time.

Mr. Stan Conners is a member of the State Frequency Committee and thus will be cognizant of all developments in the new frequency assignments.

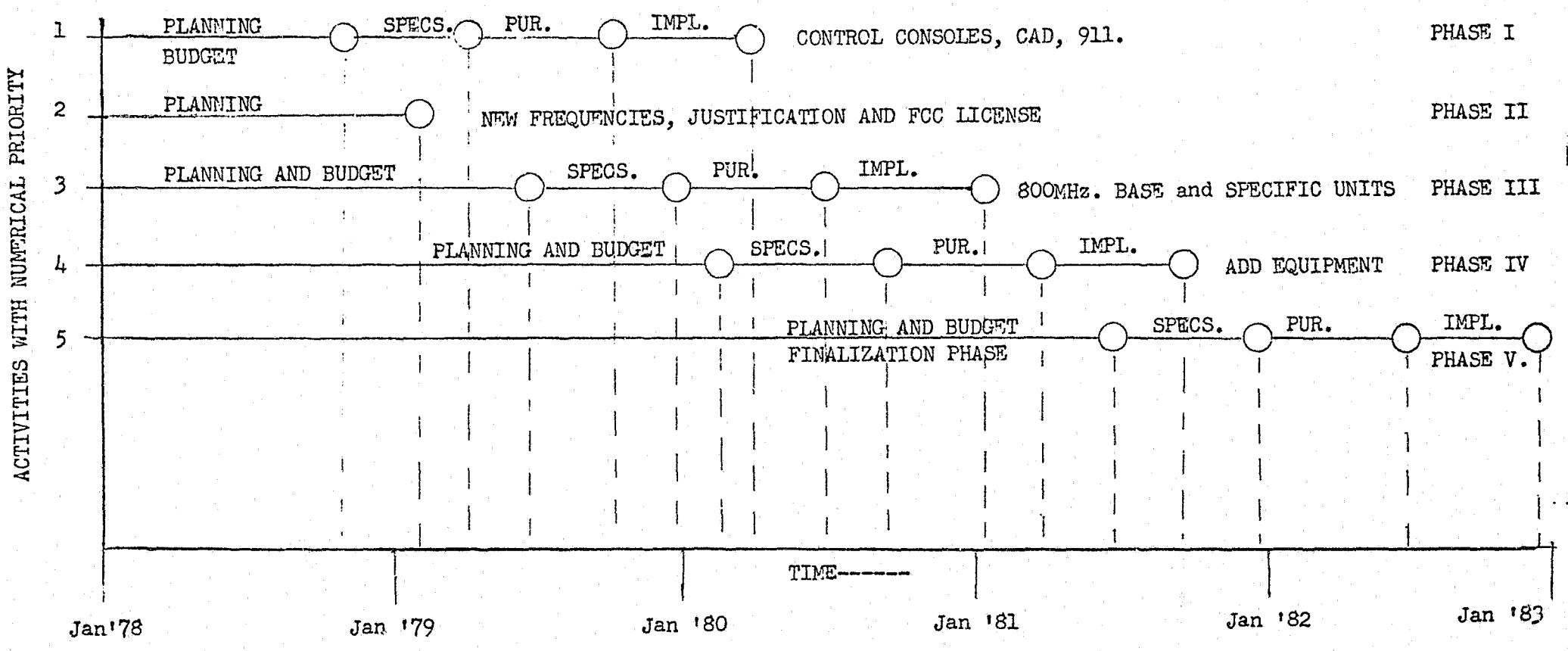
Since the 800 MHz band is a new FCC assignment, vendors have not as yet produced a complete line of equipment. The five-year time frame should allow ample time for manufacture and testing of equipment by many vendors, thus resulting in good competitive bids for the city.

At this point, a discussion of the use of various radio frequencies is in order. The lower radio frequencies, i.e., police bands of 37-40 MHz, have a longer range to field units than the higher frequencies of 150 MHz, 450 MHz, or 800 MHz. This effect is due to propagation characteristics, whereby the lower frequencies tend to bend with the earth's curvature and the higher frequencies tend to follow straight line (line of sight). This characteristic occasionally causes the users of radio equipment to stay with the lower frequencies due to the extended range. The higher frequencies can be equally effective, but the system design must consider the area to be covered (See Figure 3). Additional information may be obtained from the November, 1977 copy of the IEEE transactions on Vehicular Technology covering the 800 MHz to 900 MHz tests in several countries of the world.

Computer-Aided Dispatch (CAD)

The Tempe Police Department, under direction of Captain Terry Stewart

PROPOSED TIME-FRAME FOR COMMUNICATIONS
UP-DATING, TEMPE, AZ.



LEGEND

CAD- Computer-Aided Dispatch
911- Common Telephone Number
SPECS.-Specification Preparation
PUR.-Purchase of Equipment
IMPL.- System Implementation

} These items will vary from a few weeks to several months.

FIGURE 2

FIGURE 3

TALK-BACK RANGE CALCULATOR @ 800 MHz

INSTRUCTIONS

(1) Locate Base Station Antenna Height (See Point A).

(2) Move horizontally to correction scale (See Point B).

(3) Add (up) or subtract (down) dB of correction (Point C).

(4) Move horizontally to the mobile transmitter graph (See Point D).

(5) Read distance on the range scale (See Point E).

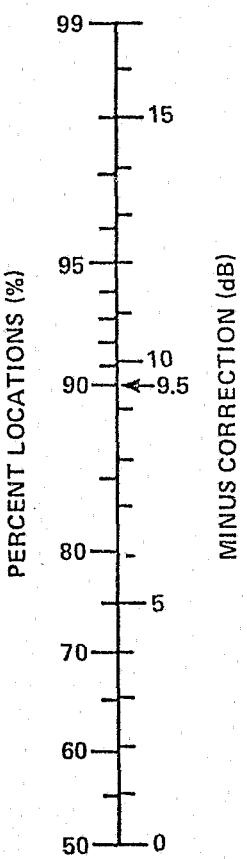
CORRECTIONS (dB)

(1) Add antenna gains

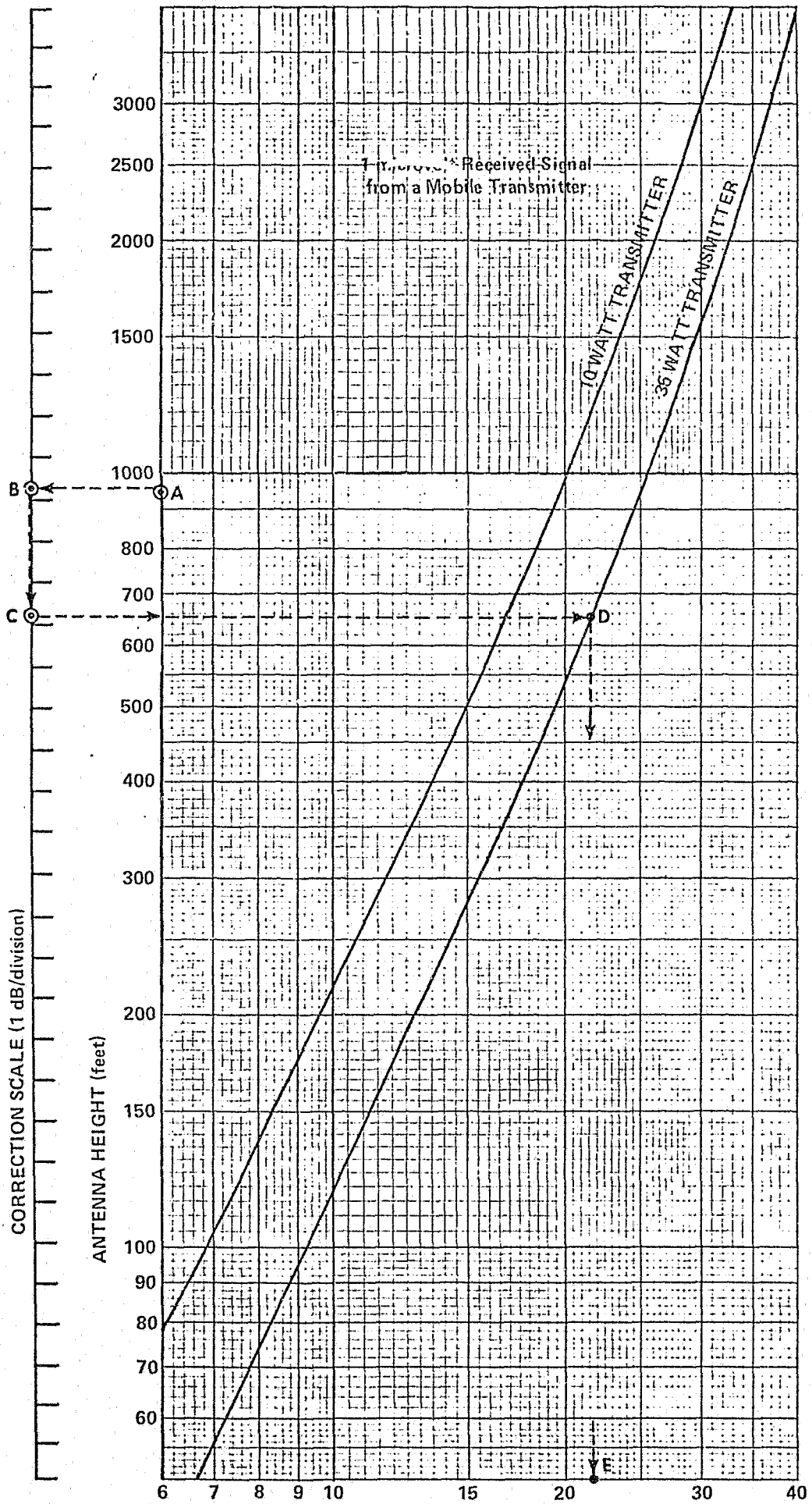
(2) Subtract transmission line losses.

COAX	1/2"	7/8"	1-5/8"
dB/100'	2.8	1.6	1.3

(3) Subtract for percent locations greater than 50% (See Scale below).



LOCATION CORRECTION SCALE



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of its Administrative Division, has investigated the preliminary functions and capabilities of a CAD system. The department is presently joining a computerized file system for all major cities in the Phoenix area. This master criminal justice storage file will provide a main computer storage. With the addition of a mini-computer at the Tempe Police Department, the CAD system becomes a possibility at a much-reduced cost.

Many cities of 100,000 population and over have installed CAD systems to save manpower and improve response time.

The enclosed diagram, Figure 4, shows the consultant's version of a very basic communications revision with CAD that can be used as a building block approach for future updating.[1/] The left side top indicates the telephone operator's position in the proposed communications center. The citizen's call information is entered into a cathode-ray-tube (CRT) terminal and appears immediately on the dispatcher's CRT. The dispatcher can then verbally relay the message to the proper police vehicle that is indicated on the CRT status terminal. The CRT terminals allow each dispatcher to query the local mini-computer files, as well as the area, state, and federal files.

Three radio consoles should be purchased with 10-channel capability for future expansion. The third position can be used by a supervisor during the day shift. The cost of communications center changes should be in the area of $200,000 to $300,000.

The incoming telephone calls, if 911 is installed, may be answered by the dispatcher, thereby eliminating one position in the communications room. This is a method now used by Tempe police and many other cities to save personnel costs.

The 911 Common Telephone Number

The 911 telephone number implementation should be requested as soon as possible for installation in Tempe. It would be desirable to have this implementation coincide with the installation of a new Communications Center with CAD.

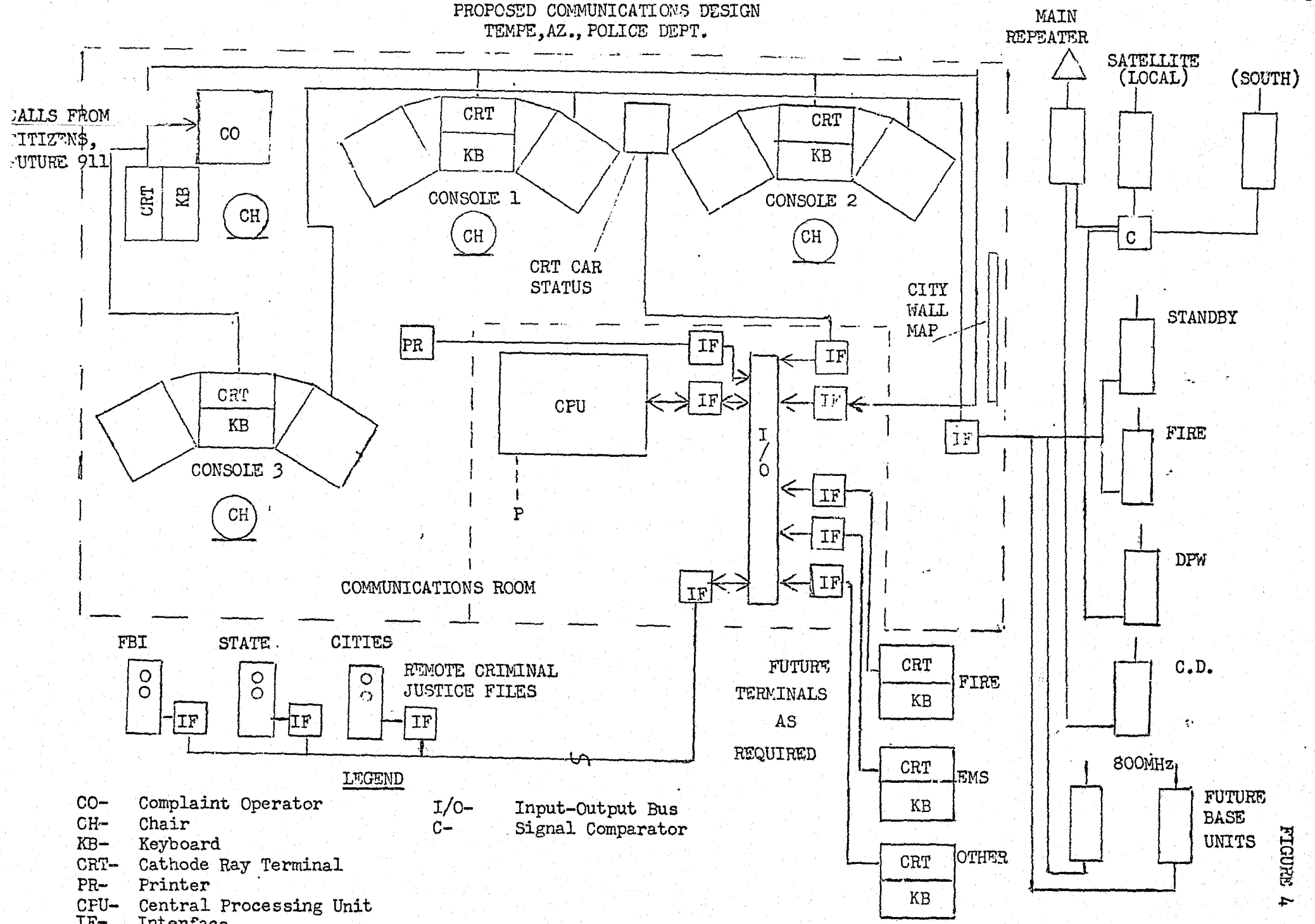
The 911 telephone number provides the citizen with a reduced response time in requesting help from the public safety agencies. Figure 5 illustrates improved response time between detection of an event and notification, with 911 as compared to a cycle without it.

Maintenance of Equipment

The Tempe Police Department has a full-time radio technician who repairs and maintains the electronic radio equipment. The service and down-time on equipment has greatly improved since he was added to the staff, but it will be necessary to provide part-time help for the radio technician.

1/ The designs and comments provided in this analysis do not constitute an engineering study for system design but provide some basic overall recommendations for future engineering designs and specifications.

PROPOSED COMMUNICATIONS DESIGN
TEMPE, AZ., POLICE DEPT.



LEGEND

CO- Complaint Operator
CH- Chair
KB- Keyboard
CRT- Cathode Ray Terminal
PR- Printer
CPU- Central Processing Unit
IF- Interface
I/O- Input-Output Bus
C- Signal Comparator

FIGURE 4

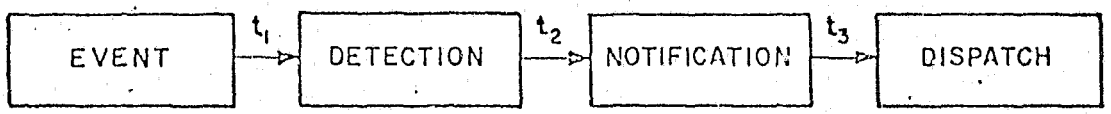
In the consultant's opinion, adding a second full-time radio technician should be considered, since the system updating will increase the technical workload. A second technician would also reduce the down-time on equipment to a minimum.

Replacement of Radio Frequency Equipment

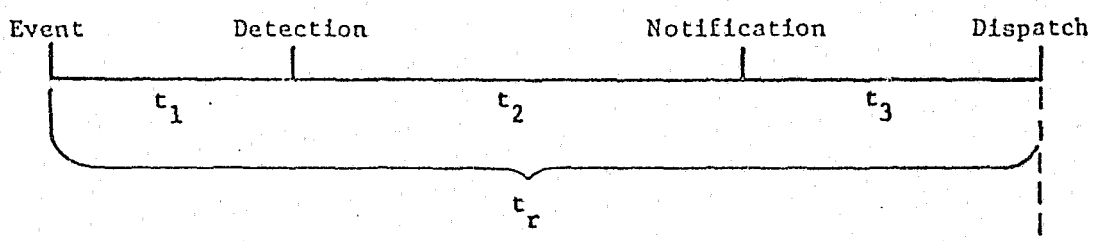
The radio equipment in use by the Tempe Police Department is generally in good condition, and only a few older units are requiring excessive maintenance. Some of the mobile units are of the single frequency design and have not been updated to utilize the newly added second radio channel.

A recommended replacement schedule is indicated in Figure 2, the proposed five-year time frame. The equipment replacement (radio frequency type) should be planned to coincide with the change of frequencies to a new band. This will insure that the new units are of multi-frequency and contain all necessary accessories or options such as tone squelch, time-out timers, etc.

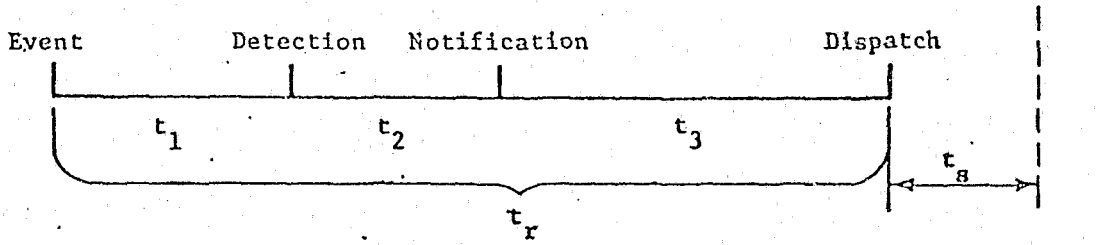
FIGURE 5



RESPONSE CYCLE DEFINITION



RESPONSE CYCLE TIMING WITHOUT 911



TIMING WITH CENTRAL DISPATCH AND 911

Note: From report of Franklin Institute Research Laboratories on Single Emergency Telephone Number, March 1970.

THE EMERGENCY RESPONSE CYCLE

III. FINDINGS AND CONCLUSIONS

The following findings and conclusions were derived from the preceding analysis of the problem.

1. FINDING

Radio consoles require replacing.

CONCLUSION

The existing two units do not have an expansion capability for the next five years. Three consoles should be planned for future expansion. Each console should have a 10-channel capability. The existing unit is approximately 6 years, and the vendor no longer manufactures this model of console.

The existing console units are not adaptable to many improved communications concepts.

2. FINDING

Radio room is not adequate in size.

CONCLUSION

The existing radio operation should be moved to a larger area. The telephone operation should be a part of the communications center.

The center should be secure, with limited access to noncommunications personnel.

The physical room should have sound-proofing, improved air-conditioning, computer-type raised flooring, and adequate primary wiring circuits.

3. FINDING

Status display requires updating.

CONCLUSION

The existing status display is only available to one operator; its wiring is poor, and the entire unit requires excessive maintenance. The unit requires the use of IBM cards for operation and would be more convenient if updated as a CRT terminal.

4. FINDING

Logging tape recorder is adequate.

CONCLUSION

The existing tape recorder has a 30- to 40-channel capability which leaves room for expansion.

The equipment is in good condition.

5. FINDING

Standby repeater base station is adequate.

CONCLUSION

The existing standby base unit is not used continuously and should not require replacement until the system frequency is changed. The primary power circuits should be re-wired to minimize future failures.

6. FINDING

Paging system requires some modification.

CONCLUSION

The pocket paging receiver units are not dependable and require excessive maintenance. These should be replaced. The base station transmitter is adequate. It would be advisable to keep this item for paging only, after the radio system is changed to 800 MHz.

7. FINDING

Random access projector is not adequate.

CONCLUSION

The slide capability is not adequate. A new type that uses microfilm would have greater capacity and require less maintenance.

8. FINDING

Alarm panel is inadequate.

CONCLUSION

The alarm panel uses obsolete parts, the wiring is in poor condition, and the unit requires excessive maintenance.

The panel and associated equipment should be updated when new consoles are purchased.

9. FINDING

The present radio frequencies are inadequate.

CONCLUSION

The two existing frequencies in the VHF band cannot be expanded due to other users in the area.

Interference from the Scottsdale police units presents an incurable problem.

There is no expansion capability for the next 5 years.

The department should consider changing the existing system to a minimum of three channels in the 800 MHz band.

10. FINDING

A CAD System implementation should be considered.

CONCLUSION

The CAD would lessen the dispatcher's work load. Computer terminals are presently in use in the department and a combination terminal would not require excessive training or maintainance.

The CAD may improve response time and reduce the operator workload. The computer storage would reduce paperwork for the operator and provide formats for the telephone and radio operators.

11. FINDING

The 911 common telephone number should be implemented.

CONCLUSION

The 911 number would reduce the citizens' response time during emergencies.

The city should plan a central dispatch operation for all public safety when 911 is installed. This would reduce operator costs and provide improved service. A central dispatch operation should conserve some radio frequency use.

The 911 implementation should occur simultaneously with the new dispatch office and CAD installations.

12. FINDING

There is a requirement for additional maintenance personnel.

CONCLUSION

The existing workload is too great for one technician and will only increase with the improvements in the communications area. An additional technician should improve the "down-time" on equipment items.

13. FINDING

There is a need for replacement of existing base, mobile, and portable equipment.

CONCLUSION

The planning of replacement units will have to be coordinated with the FCC license procurement on 800 MHz.

The first procurement might be one base station, the motorcycle units, and a few old portable units. A second and third phase of replacement could fit into a 5-year budget plan.

The signal comparator now located at the Butte radio station should be moved to the dispatch office at the time the new consoles are installed. This will result in an improved maintenance for the satellite receiver system.

IV. RECOMMENDATIONS

The following specific recommendations provide for the updating of Tempe police communications:

1. Recommend that the two existing radio consoles be replaced with three, starting immediately with the budget, planning, design, specifications, purchase, and implementation. A time-frame of 2 years should be used as a goal.

2. Recommend that the communications control room be enlarged to accommodate additional equipment.

3. Recommend that the communications Captain and the radio technician visit other control centers in cities of approximately 100,000 population that are using CAD systems (e.g., Sunnyvale, Calif.)

4. Recommend that the radio tehcnician visit some existing 800 MHz system locations that will provide background information regarding mobile coverage that might be expect in the city of Tempe.

5. Recommend that the existing car status display be updated and become a function of a CAD system.

6. Recommend that new paging units be purchased.

7. Recommend that a new microfilm random access projector be purchased within 2 years to be used in the control center.

8. Recommend a new alarm panel be purchased with the new consoles (2-years goal).

9. Recommend that immediate action start to obtain an 800 MHz frequency from the FCC.

10. Recommend that plans and budget requests for a CAD system be started to coincide with the 2-year time frame for three radio consoles.

11. Recommend that immediate action be taken for the implementation of the 911 telephone number. This is a 2-year goal.

12. Recommend that a budget request be considered to add one radio technician and one supervisor for 8 a.m.-5 p.m. shift in communications. This is a 2-year goal.

13. Recommend replacement of all radio (RF) equipment by the end of 5 years.

14. Recommend that consideration be given to the establishment of

central dispatch for all public safety communications to coincide with the 911 implementation. This will of necessity require considerable additional planning in personnel and equipment that has not been covered in this assignment.

APPENDIX A - PUBLIC SAFETY FREQUENCY ASSIGNMENTS FOR ARIZONA

(Excerpted from the Arizona Public Safety Frequency Manual)

F	154.280		Chandler; Scottsdale; Mesa; Phoenix; Peoria; Tempe; Glendale; (Inter-systems operations only (b-m));
F	154.295		(Inter-systems operations only (b-m));
F	154.310		Douglas; Glendale;
F	154.325		Mohave Valley Fire Dept.; Apache Jctn FD;
F	154.340		Prescott; Pima; Flowing Wells FD; Oracle VFD; Mesa; Fry; Naco; Palominas;
F	154.355		Hualapai Valley Fire Dist. (Mohave County);
F	154.370		Deer Valley-Rural Fire Dept.; Phoenix; Tucson; Yuma;
F	154.385		Rural Fire Protection Co.;
F	154.400		Tucson; Sedona Fire Dist.; Red Rock Fire Dist. Sedona;
F	154.415		Central Heights Fire Dist.;
F	154.430		Goodyear; Chandler; Payson; Cashion; Montezuma-Rimrock Fire Dist.; Nogales Fire Dist.;
F	154.445		Central Yavapai Fire Dist.; Havasu Fire Dist.; Holbrook Fire Dept.;
L	154.4525-154.4600		Fixed. Emergency Call Box Service.;
P	154.650	(M)	State of Az DPS.;
P	154.665	(S)	State of Az DPS Dist. II.;
P	154.680	(S)	State of Az DPS Dist. IX.; Atty Gen of Az.;
P	154.695	(S)	State of Az DPS Dist. VII.;

P	154.710	(M)	Navajo Tribe (mr 158.850); Yuma County (mr 158.730); Tempe (mr 155.685); State of Az DPS (mobile command ctr); Southern UTE Tribe;
P	154.725		Tucson; S.E. Az College-Thatcher;
P	154.740		Navajo Tribe; Yavapai County (m& c 155.580); Douglas;
P	154.755		Phoenix; Holbrook; Winslow; Taylor; Showlow; Snowflake; Navajo County SO;
P	154.770	(M)	Gila County;
P	154.785		State of Az DPS Dist. CI (m);
P	154.800		Prescott; New Mexico SP; Yuma County; Tempe PD (mr 155.835);
P	154.815		Mesa (mr); Kingman; Cochise County (mr 155.970); Sierra Vista;
P	154.830	(M)	Glendale (mr 156.210); Snowflake; Taylor; Holbrook; Winslow; Showlow;
P	154.845		State of Az DPS Dist. 6;
P	154.860		State of Az DPS Dist. VI & XI;
P	154.875		New Mexico Mt. top-transmit- Inter-City system - (receive 158.730); Kearny;
P	154.890		Phoenix (b-m); State of Az DPS (Mobile command Ctr);
P	154.905	(S)	State of Az DPS Dist. I;
P	154.920	(S)	Az. Drug Control Dist.;
P	154.935	(S)	State of Az. DPS Statewide;

P	154.950 (M)	Navajo Tribe (mr 158.970);	Mesa PD;	
L	154.965	Globe;	Tempe; (mr 155.880);	
L	154.980	Navajo Tribe;	Prescott;	Buckeye;
L	154.995	Tucson;		
		APACHE COUNTY;		
L	155.010	Mesa;	Tucson;	NAU-Flagstaff;
		N. Mexico SP-Repeater (receives 158.910);		
		Parker;	State of Az DPS (Mobile Command Ctr);	
L	155.025	Globe;	Miami;	Navajo Tribe;
		Hualapai Tribe-Peach Springs;		Utah CD;
L	155.040	Navajo Tribe;	Pima County (m);	
		State of Az Building Maintenance-Phoenix;		
		State of Az-Corrections;		
L	155.055	Nogales;	Mohave County;	Graham County;
		Mesa;	Gila Bend;	N. Mexico-San Juan County Schools-atop Roof Butte;
P	155.070	Phoenix;	Yavapai College;	
		Navajo County SO;		
L	155.085	Pima County (m & c 153.755);		Kayenta;
		N.A.U.-Flagstaff;	Page;	
L	155.100	Maricopa County;	Winslow Fire;	Benson DPW;
L	155.115	Flagstaff;	State of Az Dept. of Corrections;	
P	155.130	Coconino County (c at Fredonia & Coppermine);		
		Gila Bend;	Mesa PD (m 159.150);	
		Cochise College;		
L	155.145	Phoenix;	Town of Pima;	Navajo County E.S.;
		Tucson School Dist. I;		
S	155.160	Kords. Gold Cross Ambulance-Phoenix; Southern Arizona Rescue Association-Tucson; Dye Medical and Oxygen Supply-Phoenix; Westside Veterinary Enterprises-Tolleson; Az. Mtn. Club Rescue; Yuma Search & Rescue;		

S	155.175	Kords Ambulance-Tucson;
P	155.190	State of AZ DPS (m) Statewide;
S	155.205	Medical Com. Association-Tucson; Marana School Dist.;
S	155.220	Scottsdale Elementary and High School Dist.-Phoenix; Pima County E.S.; Mesa Ambulance; Az DPS Helicopters; Gold Cross Ambulance; Scottsdale Memorial Hosp.; Sacaton School Dist. 18;
S	155.235	Ace Ambulance-Lake Havasu City; Santa Cruz Elementary Maricopa County; Vail School; School Dist. 35; Indian Oasis School Dist.-Sells;
P	155.250	Casa Grande; Coolidge; Eloy; St. George, Utah; Chandler; Springerville and Eagar;
S	155.265	Graham County EMS; W,B. Arters-St. David; St. Marys Hosp.-Tucson; St. Lukes Hosp.;
S	155.280	Universale Memorial Service-Phonix; Dr. Jabczenski Paging-Tucson; Lake Havasu City Fire-Rescue Squad; J.P. Ellsworth,DVM, Prescott; Safford Public Schools; Arizona Animal Hosp.-Phoenix; Howell B. Hood, Tempe;
S	155.295	Doctors Paging Maricopa County Medical Service-Phoenix;
P	155.310	Gila County SO(mr., m & c 154.770);
S	155.325	Doctors Hosp.-Phoenix; Flagstaff Public School Dist.; Gold Cross Ambulance-Scottsdale;
S	155.340	Tucson Medical Center (Paging); Cochise County; Marcus Lawrence Hosp.; St. Joseph Hosp Med. Ctr.;
S	155.355	Maricopa County Hosp.; Hoemako Hosp.-Casa Grande;

P	155.370	Phoenix; Benson PD;	Kingman PD (mr 154.815); Huachuca City; Cochise County;
S	155.385	St. Josephs Hosp. Tucson;	Memorial Hosp. Phoenix;
S	155.400	Flagstaff Community Hosp.; Arizona State Hosp.; U of A College of Medicine Paging System; Cochise County Hosp. Association;	Good Samaritan Hosp.;
P	155.415	Ute Mtn. Indian Tribe - SE Utah and SW Colorado; Pima County;	
P	155.430	Phoenix (b-m);	
P	155.445 (S)	State of Az DPS Dist. VIII;	Az. Drug Control Dist.;
P	155.460 (S)	State of Az DPS Dist. III;	
P	155.475 (I-A(m))	State of Az. DPS Dist. V;	Cochise County;
P	155.490	Tucson; ASU-Tempe and Litchfield Park; State of Az DPS (mobile command ctr);	Coconino County-Coppermine (r);
P	155.505 (S)	State of Az DPS Dist. IV;	Utah Highway Patrol-Statewide;
P	155.520	Phoenix (b-m); Showlow PD; Snowflake;	Winslow; Holbrook; UTE; Taylor;
P	155.535	Pima County;	Mohave County; Williams;
P	155.550	Scottsdale;	
P	155.565	Pima County; Payson;	State of Az DPS (mobile command Ctr); Utah Highway Patrol-Statewide;
P	155.580	Yavapai County (mr 154.740); Prescott; State of Az. DPS (mobile command ctr); Needles, Cal.; N. Mexico State Police;	
P	155.595	Yavapai County;	

P	155.610	Pima County;	Phoenix PD;
P	155.625	Wickenburg PD;	Navajo Tribe;
P	155.640	Phoenix (b-m);	Sierra Vista PD;
P	155.655	Casa Grande PD;	Apache County SO;
P	155.670	U of A Tucson;	Flagstaff (m); Glendale PD; Interagency Statewide; State of Az.; State of Az. DPS (mobile command ctr);
P	155.685	Tempe (m 154.710);	
P	155.700	Pima County;	Navajo County SO;
L	155.715	Chandler;	
P	155.730	Tucson;	Prescott; Page; Fredonia;
L	155.745	Navajo County. E.S.;	
L	155.760	Phoenix;	Navajo Tribe; U of A Tucson; Needles, Cal.;
L	155.775	Coolidge;	
P	155.790	Phoenix (b-m);	Kingman (m & c 155.130); Showlow PD; Holbrook; Winslow; Taylor; Snowflake;
L	155.805	Navajo Tribe-Mt. Eldon;	
L	155.820	Mesa (m & c 153.920);	Pima County; Navajo Tribe;
L	155.835	Yuma;	Tempe PD(m&c 154.800); Cochise County; Sierra Vista PD; Bisbee; Huachuca City;

P	155.850	(M)	Scottsdale; (mr-m&c 154.845);		
L	155.865		Wickenburg;	Mammoth;	Sierra Vista;
L	155.880		Tempe (m&c 154.965);	Eloy;	Flagstaff;
L	155.895		Douglas;	Pima County;	Payson;
P	155.910	(M)	Chandler;	Az. Drug Control Dist.;	
L	155.925		Casa Grande;	Holbrook;	Cochise County;
L	155.940		Maricopa County (m&c 153.980);		Kayenta;
L	155.955		Pima County; Chandler;	Chinle;	Tuba City;
P	155.970	(M)	San Bernardino County-Hayden Peak, Maricopa County Phoenix College;		Kingman; Cochise County-(m&c 154.815);
L	155.985	(M)	Ute Mtn. Tribe-SW Colorado; Navajo Tribe;	Pima County;	Utah CD;
L	156.000	(M)	State of Az Dept of Corrections;		Navajo Tribe;
L	156.015	(M)	Mesa P.W. (m&c153.815);		
P	156.030	(M)	Tucson;	Flagstaff;	Scottsdale PD;
H	156.045	(M)	Yuma County (mr 159.195);		Mohave County;
H	156.060	(M)			
H	156.075	(M)			
P	156.090	(M)	State of Az DPS Dist. CI (mr 154.785);		

H	156.105		State of Az AHD Dist II & V (m&c 151.070);
H	156.120		State of Az AHD Dist VII (m&c 151.040);
H	156.135		State of Az AHD Dist I & IV (m&c 151.100);
P	156.150	(M)	HUALAPAI PT 155.535 Mohave County (mr); A.S.U. Tempe;
H	156.165	(C)	Tucson;
H	156.180	(C)	Phoenix;
H	156.195	(C)	Apache County (m&c 159.105);
P	156.210		South Tucson; Glendale (m-154.830); Mohave County (c); Flagstaff (mr);
H	156.225	(C)	State of Az AHD Dist III & VI (m&c 151.010);
H	156.240	(C)	Maricopa County;
H	156.990		Maricopa County (mr-160.110);
H	157.290		Phoenix;
P	158.730		Yuma County (m-154.710); Mesa; N. Mexico Inter-City System receive;
L	158.745		Maricopa County (Phoenix Union School System); Pima County;
S	157.450	(b)	One-way paging, 30 watt limit;

L	158.760		Pinal County (m see 153.800); State Prison (same as Pinal County); Navajo County (m & c see 153.800);
L	158.775		Phoenix;
P	158.790		Navajo Tribe; Pima County;
L	158.805		Yuma Co.; Mesa (L);
L	158.820		Glendale; Pima Co.;
L	158.835		Colorado, Dolores County; N.A.U.; Pinal CO.E.S.
P	158.850		Tucson; Navajo Tribe (m-c see 154.710);
L	158.865	(M)	Tempe (mR) mc 153.740);
L	158.880	(M)	Utah (receives on Navajo Mountain); Pinal County Electrical District #4;
L	158.895	(M)	
P	158.910	(M)	Tucson; Maricopa County (mr see 159.090); New Mexico (receive only);
L	158.925	(M)	Dolores County, Colorado;
L	158.940	(M)	Gila County (m & c see 154.100); Navajo Tribe (m); Las Vegas, Nevada;
L	158.955	(M)	Arizona Drug Control Dist.;
P	158.970	(M)	State of Arizona DPS District X; Navajo Tribe;

H	158.985	(M)	Pima County (mr-159.180);
H	159.000	(M)	
H	159.015	(M)	
P	159.030	(M)	Mesa (m); Tucson; N. Mexico receive; State of Az DPS (mobile command ctr);
H	159.045	(M)	
H	159.060	(M)	
H	159.075	(M)	
P	159.090		Maricopa County (mr-158.910); State of Az DPS- (mobile command ctr);
H	159.105	(C)	Apache County (mr-156.195);
H	159.120	(C)	
H	159.135	(C)	Tucson (m); Mohave County;
P	159.150		Coconino County (r); Mesa PD;
H	159.165	(C)	
H	159.180		Pima County (m&c-158.985);
H	159.195		Yuma County (m&c-156.045); Maricopa County;
P	159.210		Coconino County-Jacob Lake (r); Tucson (m); Coconino County-Mt. Elden (c);
C	159.300		Pima County (mr-151.370);
C	159.360		Pima County (mr-151.310);

H	160.110		Maricopa County (mr);
S	161.850		Joint Maricopa County Civil Defense and Disaster Organization;
S	163.250	(Paging)	Maricopa County;

P	451.100	Navajo Tribe;
S	452.250	Navajo Health Authority;
H	453.000	Az Highway Dept., St. George, Utah;
L	453.025	State of Az, AHD (call boxes) (dust warning);
CHFPL-bm	453.050	State of Az DPS Statewide (P) TCD;
L	453.075	Reserved, Highway call boxes;
CHFPL-bm	453.100	Phoenix (P); Tucson (F)
L-bm	453.125	Reserved, Highway call boxes;
CHFPL-bm	453.150	Maricopa County (P-r Thompson Peak);
L	453.175	Reserved, Highway call boxes;
CHFPL-bm	453.200	Phoenix (P); Tucson (F);
L-bm	453.225	State of Az. Pima County Community College Security; Navajo Tribe;
CHFPL-bm	453.250	State of Az Coliseum Board Statewide (L-mr);
L-bm	453.275	Tucson; Youngtown;
CHFPL-bm	453.300	State of Az DPS Statewide (P);
L-bm	453.325	State of Az AHD Statewide;
CHFPL-bm	453.350	Mesa (L); Tucson (L);
L-bm	453.375	State of Az AHD Statewide;
CHFPL-bm	453.400	Maricopa County (L)(m); Tucson (F);

L-bm	453.425	Maricopa County (L);	
CHFPL-bm	453.450	Phoenix (P);	Tucson Airport Authority (L);
L-bm	453.475	Phoenix (L);	
CHFPL-bm	453.500	Phoenix (L);	Tucson (L);
L-bm	453.525	Navajo Tribe;	Salt River-Pima-Maricopa Indian Community;
CHFPL-bm	453.550	Pima County (P-r Mt. Lemmon); A.S.U. Tempe;	Mohave County (P-r);
L-bm	453.575	Pima County;	
CHFPL-bm	453.600	Phoenix (P);	
L-bm	453.625	Pima County;	Phoenix;
CHFPL-bm	453.650	Pima County (F-r Mt. Lemmon);	
L-bm	453.675	Pima County;	State of Az Dept. of Corrections Girls School-Phoenix;
CHFPL-bm	453.700	State of Az Statewide EMS;	
L-bm	453.725	Gila River Indian Community, B.I.A.; Papago Tribe; Hopi Tribe; Hualapai Indian Tribe; Salt River-Pima-Maricopa Indian Community; San Carlos Indian Community;	
CHFPL-bm	453.750	State of Az, Phoenix (KJU255);	
L-bm	453.775	State of Az AHD Statewide;	
CHFPL-bm	453.800	PHOENIX (P);	

L-bm	453.825	State of AZ, Statewide EMS;
CHFPL-bm	453.850	Apache County-Greens Peak(P-r); State of Az Livestock Sanitary Board-White Tanks Mt. (P-r);
L-bm	453.875	Phoenix;
CHFPL-bm	453.900	Chandler; State of AZ DPS(P-r Mt. Lemmon);
L-bm	453.925	Maricopa County;
CHFPL-bm	453.950	Phoenix (L)
L-bm	453.975	
P	456.100	Navajo Tribe;
S	457.250	Navajo Health Authority-Window Rock;
H	458.000	Az Highway Dept., St. George, Utah;
SL-m	458.025	State of Az AHD (call boxes, dust warning);
CHFPL-m	458.050	State of Az DPS Statewide (P) (TCD);
L-m	458.075	Reserved, call boxes;
CHFPL-m	458.100	Phoenix (P); Tucson (F);
L-m	458.125	Reserved, call boxes;
CHFPL-m	458.150	Maricopa County (P-c);
L-m	458.175	Reserved, call boxes;
CHFPL-m	458.200	Phoenix (P); Tucson (F);
L-m	458.225	Pima Junior College Security Dept; Navajo Tribe;

HFPL-m	458.250	State of Arizona Coliseum Board Statewide (L-m-c);
L-m	458.275	Tucson;
HFPL-m	458.300	State of Arizona DPS (P-m) Statewide;
L-m	458.325	State of Arizona AHD Statewide;
HFPL-m	458.350	Mesa; Tucson (L);
L-m	458.375	State of Arizona AHD Statewide;
HFPL-m	458.400	Maricopa County (mr);
L-m	458.425	Maricopa County (L);
HFPL-m	458.450	Phoenix (P); Tucson Airport Authority (L);
L-m	458.475	Phoenix;
HFPL-m	458.500	Phoenix (L); Tucson (L);
L-m	458.525	Navajo Tribe; SALT RIVER-PIMA-MARICOPA-INDIAN COMM
HFPL-m	458.550	Pima County (P-c); Mohave County (P-c); A.S.U. Tempe;
L-m	458.575	Pima Co.;
HFPL-m	458.600	Phoenix (P);
L-m	458.625	Pima Co.; Phoenix;
HFPL-m	458.650	Pima Co.;

L-m	458.675	Pima County;	State of Az Dept of Corrections-Girls School, Phoenix (m);
CHFPL-m	458.700	State of Az EMS;	
L-m	458.725	Gila River Indian Community; Papago Tribe; Hopi Tribe; Hualapai Indian Tribe; Salt River-Pima-Maricopa Indian Community; Colorado River Indians; San Carlos Indian Community;	
CHFPL-m	458.750		
L-m	458.775	State of Az AHD Statewide;	
CHFPL-m	458.800	Phoenix (P);	
L-m	458.825		
CHFPL-m	458.850	Apache County-St. Johns (P-c); State of Az Livestock Sanitary Board-Phoenix (P-c);	
L-m	458.875	Phoenix;	
CHFPL-m	458.900	Chandler;	
L-m	458.925	Maricopa County;	
CHFPL-m	458.950	Phoenix (L);	
L-m	458.975		
P-bm	460.025	State of Az DPS Statewide;	San Bernardino County-Needles, Cal.;
P-bm	460.050	Maricopa County;	

P-bm	460.075	Maricopa County;
P-bm	460.100	Maricopa County;
P-bm	460.125	Maricopa County; Utah
P-bm	460.150	Maricopa County;
P-bm	460.175	Maricopa County; Utah
P-bm	460.200	Maricopa County;
P-bm	460.225	State of Arizona DPS, Statewide;
P-bm	460.250	Peoria; Tolleson; El Mirage; Surprise; Youngtown; Avondale; Goodyear;
P-bm	460.275	State of Arizona DPS Districts II & VI;
P-bm	460.300	State of Arizona, Districts III & X;
P-bm	460.325	State of Arizona DPS Districts V & IX;
P-bm	460.350	Yuma; Paradise VAlley, U of A P.D.:
P-bm	460.375	State of Arizona DPS Statewide Interagency;
P-bm	460.400	State of Arizona DPS Districts IV & XI;
P-bm	460.425	State of Arizona DPS Districts VIII & XII; Uta
P-bm	460.450	Yuma; Gilbert;

P-bm	460.475	State of Az Dist I & VII;
P-bm	460.500	State of Az DPS;
PS-bm	460.525	Phoenix (P);
PS-bm	460.550	Phoenix (P);
F-bm	460.575	
F-bm	460.600	
F-bm	460.625	Sun City Volunteer Fire District;
S-bm	462.950	(P thru 1985 Grandfathered, no new licenses.)
S-bm	462.975	(P thru 1985 Grandfathered, no new licenses.)
S-bm	462.950/ 467.950	State of Az DPS Statewide; City of Phoenix; City of Tucson;
S-bm	462.975/ 467.975	State of Az DPS Statewide; City of Phoenix; City of Tucson;

Following list is of Special Emergency MED-1 thru MED-8 pairs of frequencies. User list follows frequency listing.

Med. One	463.000./468.000
Med. Two	463.025./468.025
Med. Three	463.050./468.050
Med. Four	463.075./468.075
Med. Five	463.100./468.100
Med. Six	463.125./468.125
Med. Seven	463.150./468.150
Med. Eight	463.175/.468.175

P-m	465.025	State of Az DPS;
P-m	465.050	Maricopa County;
P-m	465.075	Maricopa County;
P-m	465.100	Maricopa County;

P-m	465.125	Maricopa County;
P-m	465.150	Maricopa County;
P-m	465.175	Maricopa County;
P-m	465.200	Maricopa County;
P-m	465.225	State of Az DPS Statewide;
P-m	465.250	Tolleson; Peoria; El Mirage; Surprise; Youngtown; Avondale; Goodyear;
P-m	465.275	State of Az DPS Statewide;
P-m	465.300	State of Az DPS Dist. X;
P-m	465.325	State of Az DPS Statewide;
P-m	465.350	Yuma; Paradise Valley;
P-m	465.375	State of Az DPS Statewide InterAgency;
P-m	465.400	State of Az DPS Statewide;
P-m	465.425	State of Az DPS Statewide;
P-m	465.450	Yuma; Gilbert;
P-m	465.475	State of Az DPS / CI (Statewide);
P-m	465.500	State of Az DPS Statewide;
P-m	465.525	Phoenix (P);

END