STATE OF IOWA

TELECOMMUNICATIONS PLAN

For

LAW ENFORCEMENT AGENCIES

FINAL REPORT

VOLUME II

REFERENCE DATA

and

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It is the sincere desire of our staff to witness the full development of working systems based upon the plan.

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Cedar Rapids, Iowa

TABLE OF CONTENTS

spectra associates inc.
CEDAR RAPIDS, IOWA
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Table of Contents Continued

Table of Contents Continued

Table of Contents Continued

spectra associates inc.
CEDAR RAPIDS, IOWA
COMMUNICATION SYSTEM SPECIALISTS

LIST OF TABLES

List of Tables Continued

LIST OF FIGURES

LIST OF FRAMES

1.0 INTRODUCTION

This volume provides a collection of the detailed efforts which support the State of Iowa Telecommunications Plan contained in Volume I and its Appendix.

Objective planning criteria and guidelines are used to form the technical foundation upon which the system frequency plan and channel requirements are developed. There are sections which provide detailed tables of data for those who wish to learn the reasons for and magnitude of factors upon which many decisions are made in the development of this comprehensive plan.

Predictions are shown for the anticipated modes of radio communication signal reliability which will occur in system usage. These are prepared using contours of service probability index (SPI) which indicate the confidence level that the required grade of service will be met ninety-five percent (95%) of the time in more than ninety-nine percent (99%) of the system service area.

Time phased cost estimates and priority based schedules are developed to guide the county and area planning personnel.

Provided are operational performance check-out procedures, system operational procedures, system management suggestions, and recommendations are given for operating policy, purchasing, system maintenance, and for the technological improvements which may be later incorporated. Definitions and explanations of terms and references are provided in later sections.

The development of this volume and the generic plans in Volume I is intended to provide individual county planning groups and various approval agencies with all possible information items. However, it must be recognized that each specific installation will have a differing location requirement, operating conditions and present equipment usage which will cause individual agency planning personnel to expend additional efforts, especially in the Comm Center plan development. Planning efforts may require either Crime Commission technical staff personnel, State Division of Communications Staff, and possibly other professional assistance. This should be considered when budgeting, scheduling and prior to contracting for installation.

2.0 TELECOMMUNICATIONS SYSTEM PLANNING OBJECTIVES AND REQUIREMENTS

2.1 PLANNING OBJECTIVES

The telecommunications planning effort of this study has developed a state-wide plan shown in Volume I and in this report. This plan considers the communications requirements of all law enforcement agencies and their co-operating public safety and emergency agencies, and when implemented will provide better service to the citizens of Iowa. A goal in the final plan development is to design a system having a high degree of effectiveness and efficiency that performs with minor additional physical expansion for a period up to fifteen (15) years.

The following planning objectives were used to provide background and guidance for systems requirements development relative to state-wide law enforcement agencies. These requirements became the basis for the development of specific telecommunications system implementation plans. These objectives are expressed involving the use of known facts and parameters, and it is intended that they can be readily interpreted by users without misunderstanding. In Section 3.0 present system deficiencies are presented based on comparison with these requirements.

1. Law enforcement telecommunications systems should be available at all times to assure that those who need law enforcement assistance may obtain it with minimum delay. The public should, in an emergency be able to contact a law enforcement agency immediately by making a single telephone call. Reference 1 (f)

2. The system should provide a highly reliable base-to-mobile and mobile-to-base radio communication which will be available at all times for authorized agency officers to cooperate in emergency maneuvers, to request aid and information, and to receive agency command instructions within the agencies' jurisdictional areas and with a minimum of delay time. Reference 1 (h)

3. The telecommunications system will ,vide interconnecting linkages to adjacent law enforcement anc to related cooperating fire departments and emergency medical se rvices agencies in order to obtain an efficient mutual support.

4. The telecommunications system should be designed to be economical in both cost and frequency spectrum usage through a provision that dispatch centers and associated facilities serve a sufficiently large geographical area, and population size.

5. The system should have an adequate inventory of well-maintained terminal and link equipment and system operators should utilize well-developed operation plans and procedures which have provisions for maximum coordination of public safety and emergency agencies with law enforcement agencies during normal operational periods and during emergency circumstances, including area-wide disasters.

6. Functional requirements should be defined in objective terms not subjectively affected by personal opinions, preferences, and biases. Measurable standards and minimum limits should establish the acceptable performance of the system functions.

DISCUSSION OF OBJECTIVES

Law enforcement and public safety communications via radio systems, data systems and video telecommunications are presently undergoing marked changes. These changes are brought about by recognizing a need for reduced assistance-request-response time. Also, changes are needed to achieve the communication goals of these agencies' activities, because of an increase in criminal activity, and through previously uncoordinated systems changes by various agencies. The radio spectrum is presently serving land-mobile and Point-to-Point operations in a manner which causes serious and unacceptable interference, unreliability and serious delays in communications.

Spectrum availability offers prospects for certain improvements, but many problems must be solved in new systems planning. The VHF low-band operations provides serious problems which are connected with physical phenomena such as skip interference. Precipitation static plus man-made external noise often makes it difficult to meet the implementation and reliability goals of future systems. Expansion of system message traffic capacity and improved utility of existing channels makes necessary a spectrum coordination planning activity which has more impact than ever before.

In establishing system requirements both the performance and the cost of making effective use of natural and man-made resources are important to consider. Examples of resources include:

- The number of available frequency channels
- The number and capacity of telephone lines and data links,
- Available terminal equipment,
- System time response performance,
- Money and operational manpower.

Additionally, it is important to establish criterion for specifying and measuring the quality of the function performed. Many of the requirements may be defined in terms of allowable limits for various modes of system functional performance. These limits may be stated in terms of the range of any specific function, its accuracy, the completeness of the function, the reliability of the function, a time delay or response time of the function and other special parameters that may be defined and used.

Functional performance goals are important to define and must be separated from details of specific implementation, i.e. the equipment and system hardware which are required to provide the functions. Performance may be evaluated through use of limiting criteria lists which allow performance measurement for each specific function and thereby establish standards for operation. The standard limit (value for criterion) must provide an acceptable level of service. Proper standards for requirements provide that the minimum permissable performance levels are exceeded a large percentage of the time.

2.2 SPECIFIC REQUIREMENTS AND DISCUSSION

The requirements which are presented in this section have been reviewed by the LEATAC and were revised in accordance with suggestions made by its members. The list of categories of requirements is:

(1) General system requirements
(2) Communications Center (Comm Centers)
(3) Communications links
(4) Operating procedures
(5) Dispatch and operations personnel training
(6) Maintenance standards
(7) Physical facility
(8) Comm Center operations management

A discussion of each of the requirements is provided which explains its application to specific agencies and describes its meaning.

2.2.1 TELECOMMUNICATIONS SYSTEM - GENERAL

Requirement (1): The telecommunications system shall provide a good commercial voice intelligibility of circuit grade five (5). This produces an intelligibility of greater than eighty percent (80%), ninety-five percent (95%) of the time and an articulation index of greater than 0.25 for all terminal links (radio/telephone). Reference 6.

Discussion: Of primary importance to the officer who is using the communications system is his ability to achieve a high voice intelligibility at all times and under all conditions of his activity. His ability to perform the duties of his office depend on accurate and rapid response from a dispatcher or from another office with whom he must coordinate. The criteria of this requirement is based upon standards of measurement of intelligibility (Reference 1) and upon grades of service which have been defined for public safety, land mobile and other communications services.

Requirement (2): The telecommunications system shall provide flexible and efficient interfaces between telecommunications (radio, telephone and data) links, especially for agencies needing cross-agency linkages.

Discussion: Law enforcement communications systems need to employ a more efficient method for communication linkages between its radio links and the telephone and data links. Dispatchers now must provide an ear-to-mouth and to-keyboard transfer for most of these linkages. The objective is to provide a more direct linkage, thus reducing dispatcher load and translation errors. The dispatcher must monitor the radio links (FCC) and should also do so for the telephone and data links.

Requirement (3): The radio communications system shall employ a frequency plan which shall not due to co-frequency signal interference degrade the confidence level of the grade of service, as predicted without interference between stations, by more than five percent (5%). It shall have provisions for cross-agency linkages and shall be compatible with adjoining state frequency plans. The plan should reduce nuisance interference with tone coded squelch for primary agency channels decoded at Communications Centers.
Discussion: Co-frequency interference is unwanted communication and reduces the reliability of desired communications. Interference of this nature can be suppressed by proper selection of frequencies for areas with the objective of reducing destructive interference to a vanishing point and can further reduce nuisance interference through use of tone coded squelch. This requirement is consistent with nearly all modern police communications systems upgrading and for new system development plans.

Radio communications between units operating near state boundaries presently are unable to communicate across the state boundary. This can be overcome via a common nationwide compatible radio channel. Compatibility is important because of the increasing mobility of wanted persons who should be apprehended before they have traveled beyond the range of recognition.

Requirement (4): Minimize system implementation costs by careful selection of base and remote station sites to take maximum advantage of terrain and shortest inter-agency telecommunications links.
Discussion: Optimum site selection for base and remote base towers is a complex function of signal coverage in a jurisdictional area, the terrain lengths and type of control links, power output antenna height (tower) and subjective parameters which involve administrative and political factors. The requirement assures these factors are considered meeting performance (signal reliability) criteria.

Requirement (5): Provide operational stand-by equipment (both radios and emergency power generation) to assure communications capability when primary equipment has been disabled by malfunction or local power failure.
Discussion: Law enforcement communications systems standards require a reliability which cannot be provided without minimum items of stand-by equipment and emergency power generation. The need is greatest when natural or man-made disasters have occurred Equipment catastrophic failures should not result in loss of the primary Operations Channel when there is stand-by equipment.

Requirement (6): Provide base and remote base stations, repeaters, and their antenna systems to meet the radio circuit merit grade 5 in the desired service area. Illumination beyond desired service areas shall be curtailed by limiting antenna height and output power (use power and antenna selection according to area) and through radiation pattern implementation.
Discussion: Other items related to optimum siting interference and reliability adequately describe the rationale for this design requirement.

Requirement (7): Provide area transportable emergency communications systems which can be dispatched for temporary service under disaster conditions. These shall be self-sufficient units with emergency power supply, transportable tower (40 to 50 feet) and radio equipment capable of transmitting and receiving all frequencies used by the area emergency service agencies.
Discussion: County or multi-county areas may utilize such a transportable system as an adjunct to Civil Defense Emergency Systems. This requirement is in keeping with National Civil Defense standards and objectives for emergency preparedness activities.

2.2.2 COMMUNICATIONS CENTERS

A communications center (Comm Center) is the terminal in which telecommunications operations occur and provision for its operation should allow efficient and full time communications operations with all facilities which are required for serving single and joint agency operations for which the Comm Center exists.

Requirement (1): Comm Centers should be developed to provide dispatch command and control terminals for public safety and emergency agencies in an area and be a part of an Emergency Operations Center whenever feasible. Their development should be in accordance with area emergency operating plans.

Discussion: Each Comm Center should have physical security and area-wide telecommunications capability which allows for its becoming an emergency or disaster operations center when needed. The operations of the normal law enforcement activities should not be degraded when emergency operations occur.

Requirement (2): The Comm Center shall provide twenty four (24) hour, seven (7) day per week service manned with operating personnel having proven capability.

Discussion: The dependence upon the Comm Center from its mobile users and from required inter-agency activity necessitates that Comm Centers should be manned at all times. Trained dispatch personnel can perform a superior job of providing accurate dispatch services.

Requirement (3): Provide physical security for Comm Center operations and for its personnel.

Discussion: The Comm Center should be protected from unauthorized intrusion. The terminal facility should allow access for only persons whose job duties relate with the dispatchers. This security protection should restrict personnel entry from the street and thus make it possible for the dispatchers to operate without interruption. This requirement is in line with national standards for law enforcement agency operations, Reference 1 (g).

Requirement (4): Provide in the Comm Center design a margin of facility growth to meet expanding community needs and permit future requirements to be implemented without major systems replacement.

Discussion: Growth is due largely to technical advances and an increasing need for channel capability in an area. It is not cost effective to rebuild or replace large amounts of equipment when upgrading a facility.

Requirement (5): Insure sufficient links for affiliated agency commanders to have access to their personnel directly within the response time cited in Requirement 8.

Discussion: The Comm Center may provide dispatch facilities for more than one agency. All agencies affiliated with the Comm Center should have immediate and responsive access to their personnel as if they had their own communications dispatch terminal. This goal will be met because of superior equipment, procedures, operating techniques and dispatcher training.

Requirement (6): Provide adequate numbers of emergency telephone lines for emergency requests from the public and for telecom (telephone and data) linkages to affiliated agencies. Grade of service for emergency request lines shoul be less than one (1) busy in one thousand (1,000) calls at busy hour. Reference 1 (f) and 4.

Discussion: There are several areas for growth in concentration of emergency requests from the general public and from affiliated agencies through telephone and data systems. There is a national emphasis for communities to use the emergency 911 system. This will require increased capacity in the Comm Center. A sufficient number of lines should be switched into the dispatch terminal so that the response time and overall delay of call answering and responses is maintained at peak message traffic periods. The efficiency of the activity for emergency response to the public and to affiliated agencies can be improved in this way. Data services will be expanding during the coming decade. Mobile units soon will make a direct access to terminal facilities.

Requirement (7): The Comm Center must provide adequate inter-agency links, e.g., Point-to-Point radio communications, central records facilities (manual and/or TTY), incoming emergency calls, inter-agency telephone links (Centrex).

Discussion: Adequate links can be determined by traffic loading and response performance criteria standards versus the peak traffic conditions. When response time at peak traffic hours approaches limits, the system must expand the number of critical links. Reference 2.

Requirement (8): The Comm Center dispatch functional unit must provide an emergency request answering delay (either telephone or radio) of less than fifteen (15) seconds and an emergency action response to that request in less than two (2) minutes at least ninety percent (90%) of the time. This requires provision of an adequate number of channels and control dispatchers.

Discussion: The emergency request delay time is important when operating an efficient law enforcement system. The fifteen (15) seconds delay is less than the maximum standard established by the National Criminal Justice Commission. It is a standard which the Iowa LEATAC desires. This choice is consistent with the emergency medical services request delay criterion and it is believed that this design requirement is a goal for operation of the Comm Center. Action response time is equally important in that the dispatcher should be able to receive a request message, locate an active officer, and instruct him in the required emergency action in less than two(2) minutes. The important role of the Communications Center capability is that there be an adequate number of channels for assuring this response time, for a restriction can limit the response time.

Requirement (9): Provide separate, parallel dispatch operating positions with duplicate control functions in those Comm Centers where the anticipated total (telecom and radio) message traffic loading necessitates the use of more than one dispatcher.

Discussion: In keeping with the response time and request delay time of Requirement 8, it is necessary that the dispatcher load remain below a minimum which would provide for a response delay in answering incoming calls or in taking appropriate action. Dispatcher loading should not exceed a next task acceptance time of greater than fifteen (15) seconds. The ability to utilize additional dispatch positions should be built into the system or easily added to the system.

Requirement (10): Provide a monitor panel system designed for reliable visibility and detection of area intrusion and fire alarm signals.

Discussion: This requirement calls for a standard design which will provide reliable identification and should be readily visible from the normal dispatcher operating positions.

Requirement (11): Provide controls for all the remote telecom and ancilliary functions used or performed by the Comm Center dispatch function.

Discussion: The Comm Center control panel should provide flexibility for all direct and remote control ancilliary functions. Human engineering should be provided for efficient dispatcher operation and should be simplified to reduce errors.

Requirement (12): Provide current status and map displays for active personnel and vehicles in the area. Provide accurate location and routing information for dispatched emergency vehicles.

Discussion: A multiple agency dispatch center often will serve a larger area or population density than a single agency Comm Center. This requires usage of status and area display devices.

Requirement (13): Provide facilities for recording and playback of the radio and emergency telephone channels. Reference 1 (g).

Discussion: Recording and playback facilities are being recommended by the Public Safety and Criminal Justice Commission review committees in establishing standards for operation and performance of modern communications systems. A direct recording is admissible evidence in a court providing it is identified adequately.

2.2.3 COMMUNICATIONS LINKS

The communications links of a system fill many important functions. There are point-to-point links that may be satisfied through a radio or radio channel or by a common carrier (telephone lines). All emergency lines should be "A" service to insure a dial tone at all times.

Telephone lines may be dedicated or they may be dial-up. A dial-up line may be used with 7-digit dialing or they may be connected through a special system switching center (Centrex) with intra-agency dialing reduced to four (4) digits.

Radio links can have similar digital dialing to alert the agency to be contacted. A mobile unit and base Comm Center communications link must be considered for both the mobile-to-base and base-to-mobile operation. There is a difference in the potential link reliability of mobile-to-base and base-to-mobile. However, when the mobile-to-base and base-to-mobile links meet the grade of service requirement, communications will be reliable.

Mobile-to-mobile services form an important radio communication link for mutual-aid and inter-agency support. Establishing requirements for mobile-to-mobile communications over a range of the entire operating area of the Comm Center jurisdiction poses problems but may well be worth the effort and cost required to resolve.

<u>Requirement:</u> (1) Operations Radio Channel
Provide a primary agency Operations Channel for base-to-mobile and mobile-to-base radio service.

(a) The primary agency (routine operations) radio links, mobile-to-base and base-to-mobile shall meet a service probability index (SPI) which assures that the desired grade of service for radio communications is met over the required service area. Reference 7.

(b) Marginal coverage area in the area of service shall not exceed one percent (1%) of the desired service area.

(c) Additional channels shall be provided when the primary channel utilization exceeds a busy hour peak of .33.

Discussion: The required grade of service must be met for both mobile-to-base and base-to-mobile operations. To do so requires a system design that considers each of the system variable parameters, so that an adequate margin is provided at all times. This approach allows a worthy margin beyond the minimum reliability limit of service grade five. An additional factor which must be established is that the marginal reliability area [where the confidence factor (SPI) is less that fifty percent (50%)] does not exceed one percent (1%) of the total service area. This assures that the desired grade of service can be met over the entire area. The under utilization of frequency spectrum should be avoided due to spectrum crowding. Additional channel assignments must be fully justified through proof of utilization.

Requirement (2): Mobile-to-Mobile Channels

A. Provide a local law enforcement mobile-to-mobile radio communications link. This channel shall be capable of meeting the required grade of service to a range of fifteen (15) miles.*

B. Provide a Tactical Channel (Mutual Aid) for inter/intra-agency law enforcement and emergency service (EMS) emergency communications. Utilize the common state-wide/nationwide standard frequency of 155.475 MHz in accordance with strict governing rules. County Comm Centers and associated base stations will transmit on this channel to coordinate all law enforcement vehicles involved in the emergency. Reference 1 (h).

Discussion: The Criminal Justice Commission Communications Committee recently published standards (Standard 23.3) for law enforcement agency communications, indicating that a Mutual Aid or Tactical mobile-to-mobile radio communications channel should be available for operation between all agencies of law enforcement. A Tactical Channel availability allows preservation of normal operational channel integrity and traffic during emergencies. The implementation of a statewide channel thus insures direct communications with all elements working together in an emergency situation. This is further exemplified by the practice in the Illinois ISPERN system and in plans being developed by the states of Wisconsin, Minnesota, Iowa, and Missouri. At the 39th Annual Conference the APCO appointed a committee to review a nationwide Mutual Aid and Tactical Channel at the request of the FCC.

* Mobile-to-mobile communications were later allowed to use the Operations Channe and Information Channel (mobile only) frequencies.

This channel must be utilized in accordance with strict operating procedures and should be monitored by the Highway Patrol Radio operators to assure compliance of all users. Base station and mobile operations on this channel must be minimized to assure it is lightly loaded. Emergency medical vehicles should have access to the channel through the cross licensing arrangement with the Department of Public Safety.

Requirement: (3) Inter-agency Communications Channels

A. Provide a reliable radio point-to-point communications link for use between state, county, and municipal law enforcement agencies. This link should have a capability for data and voice transmission. Selective agency calling should be utilized for this link.

B. Provide a radio channel for two-way information access by municipal, county, state law enforcement mobile units. The channel shall be capable of both voice and data transmission.

C. Provide telecommunications links between the Comm Center in an area and the agencies of law enforcement emergency medical and fire departments served by its functions. These links shall be provided in sufficient number to meet all the criteria for request response time and provide a minimum in action delay.

D. Provide telecommunications capability to adjacent communications centers and into adjacent state law enforcement agencies when the area is adjacent to another state.

Discussion: These requirements recognize the need for inter-agency communications between the Iowa Highway Patrol, county sheriffs, municipal law enforcement agencies, fire departments, emergency medical services and other agencies involved in emergency services.

The normal operation of inter-agency communications centers involving state, county, and municipal agencies can be conducted over dial-up or dedicated telephone links and through use of data link devices. The use of telephone or data links is recommended over use of radio channels. However, a point-to-point radio link for emergency and disaster situation utilization is desired when the common carrier may have become overloaded or is otherwise unreliable. A selective capability on the Point-to-Point link will reduce the nuisance interference commonly found on an rf-squelch-only radio system.

The use of information systems in the past two (2) to three (3) years has necessitated the requirement that the Comm Center provide an Information Channel in addition to the primary agency Operations Channel for base-to-mobile and mobile-to-base two-way linkages. The guidelines therefore should provide local, municipal and county law enforcement communications with a two-way voice or data request to an agency having a direct data terminal access. This makes it unnecessary for each agency to have a data terminal since the information system access can be provided through the area Comm Center.

There is a state-wide Emergency Medical Services Communications System (EMSCS) under development. This system plan provides the alternates for individual dispatch Comm Centers or for the inclusion of emergency medical communications dispatch with the local or area wide law enforcement Comm Centers. Under either condition, the EMSCS activity should be interconnected to the Comm Center of law enforcement agencies, for there must be a close relationship maintained between these emergency services.

Requirement (4): Emergency Requests

For emergency request links, the area law enforcement Comm Center shall receive the emergency complaints and provide action commands. Telephone calls originating in an affiliated agency jurisdiction area should be automatically transferred to the Comm Center if not answered locally after the first ring.

Discussion: There is a nationwide movement and a recognition of the need to provide a single number emergency service telephone circuit for citizens who need emergency services. It is recognized that this activity will require passage of time and that interim methods for operations of emergency request transfer will be necessary. This requirement recognizes the need for certain local emergency requests activity.

Requirement: (5) Portable Radio and Paging

A. Provide an ability for law enforcement officals to utilize portable radio units.

B. Provide an ability for selective emergency calling having two-way response capability for officers requiring a portable unit.

C. Provide an ability for selective tone paging of individuals one-way.

Discussion: Portable units have an increasing importance in law enforcement communications technology. A separate frequency channel should be available for portable transmission to either base stations or for relay to a base station or mobile unit.

The selective calling provision should allow for calling of individual personnel in the area where reception is desired.

2.2.4 OPERATING PROCEDURES

Develop and provide for all dispatch personnel a valid written procedure for normal, emergency and disaster communications. Reference 3.

Discussion: Operating procedures which are commonly applied by all dispatch personnel can improve the accuracy, efficiency, and overall performance of a communications system. Law enforcement agencies must communicate among their own personnel and with other public safety and emergency agencies at times when there are area emergencies and general disasters. Consistent procedures used by all agencies are especially beneficial at these times. See Section 6.0 of this volume.

2.2.5 DISPATCH AND OPERATIONS PERSONNEL TRAINING

Requirement: Develop and provide a communications training program for all dispatch and operations personnel who engage in link traffic. This program shall be established and administered state-wide in accordance with sound educational principles.

Discussion: Communications personnel and others who engage in message traffic can perform their proper role when they know and can practice efficient and consistent procedures under normal, emergency and disaster modes of service. Formal training programs conducted by skilled training personnel can save many weeks of haphazard on-the-job training which may not develop personnel having a satisfactory capability. See Section 7.4 of this volume.

2.2.6 MAINTENANCE STANDARDS

Requirement: Develop maintenance standards for the uniform test, repair and calibration of communications system equipment. The standards shall become the criteria for either the selection of maintenance contractors, or the development and review of agency maintenance programs.

Discussion: Law enforcement agency communications equipment reliability is very important to the achievement of the agency objectives. Equipment performance can seriously deteriorate without being perceived by operational personnel. Maintenance personnel with proper skills and provided with adequate instruments can detect deficiencies and maintain the system at design performance levels during its lifetime. See Section 5.0 of this Volume.

2.2.7 PHYSICAL FACILITY

Requirement: The areas in which the telecommunications equipment is located and operated should be facilities designed to be reasonably secure from physical attack and sabotage.

Discussion: This security should extend to telephone trunk lines running to the telephone service facility and to the radio transmission line running between the transmitter/receiver and the antennas.

2.2.8 COMMUNICATIONS CENTER OPERATIONS MANAGEMENT

Requirement: The management of a Comm Center within an area shall be established utilizing a governing board which is representative of the agencies which are served by the Comm Center.

Discussion: This governing board shall be responsible for establishing policy and assuring the policy is met by the Comm Center supervision. Policies shall be developed meeting at least the general requirements of the following items:

A. Develop a funding basis with agreements for cost prorations on an equitable basis between the agencies served.
B. Develop an operations control policy.
C. Develop a means of selection, and evaluation of the Comm Center supervisor.
D. Assure that priorities for agency messages are established and assure that these are met in handling messages and in the assignment of action items.
E. Assure that proper training procedures and maintenance are utilized for the center operations.

See Section 7.1 of this volume.

3.0 PRESENT SYSTEM MODELS AND EVALUATION

In this section a summary comparison is presented involving the present system performance comparison with the desired performance requirements. This provides a list of major deficiencies for the system parameters analyzed. An upgrade in design can be based on guidance received from such an analysis.

3.1 PRESENT SYSTEM PERFORMANCE COMPARED WITH PLANNING OBJECTIVE - SUMMARY

The five (5) fundamental systems objectives to be met when planning a system upgrade for law enforcement communications were stated in Section 2.1. The assessment of each of those objectives versus present systems capability will summarize the situation and is supported by evaluation of present system performance in the following paragraphs and subsections.

1. Emergency requests from citizens for law enforcement assistance is generally provided for in each community. Responding agencies appear generally to have emergency telephone numbers although some did not report their emergency lines separate from administrative lines. The primary deficiency is evident in there being no commonly known telephone number for emergency requests and complaints. Each community has a number and in a given telephone directory, this number may or may not serve the entire area. This forces many people to call the telephone operator for emergency complaints. That action entails a delay and generally a non-direct contact with the correct agency.
2. Low reliability exists for state-wide base-to-mobile and mobile-to-base radio communications for all agencies utilizing 37.10 MHz single frequency low-band radio link. It is not reliable largely due to the mutual interference of a great many stations. Mobile-to-base communication is jeapordized by base-to-base interference making the reliability much less than that required for law enforcement communication. The result jeapordizes the agency response time and ability of an officer to request and obtain needed information in the minimum time delay needed for his safety and efficiency. The cause of this situation is multi-faceted involving:

a. Excessive signal strength of many radiating sites.

b. Interference from co-frequency base stations which cause long distance reception of unwanted signals.

c. Inadequate signal strength of the own-agency mobile units to offset base-to-base signals producing a marginal reliability of communications within the area which the law enforcement agency serves.

d. Inadequate utilization of a multi-frequency plan which would provide protection against destructive co-frequency interference.

e. Skip interference and precipitation static noise power produced on low-band by natural phenomenon offers an additional reduction communications reliability.

f. Many facilities do not maintain a twenty four(24) hour/seven (7) day dispatch operation.

3. Inter-agency communication linkages between the state, county and municipal law enforcement agencies exists presently through the common statewide frequency used by all those operating on low-band VHF (37.10 MHz) and through the cross-band linkage with the Iowa Highway Patrol Operating on 42.58 MHz. The effectiveness of this is greatly reduced by the unreliable operation. Many agencies within the state dispatch jointly from one communications base station in their community for law enforcement, public work, schools, and conservation and other local and municipal agencies. This enables a desirable cooperation. Because of the unreliability and statewide usage of a single channel, the effectiveness of this is very marginal.

4. The cost of the telecommunications system is composed of two primary items:

a. The capital equipment cost

b. Operations and maintenance costs.

The present system has several hundred operational centers statewide with a marginal system utilization and inordinately high operations cost.

The present system is often operated by untrained and non-professional dispatchers at a pay scale well below the professional level. The dispatch services often provided are not adequate. Many of the civilian dispatch personnel are inadequately trained and only through personal dedication, an interest in learning the necessary procedures and by gaining experience in enforcement activities do they achieve a reasonable quality of performance.

Frequency spectrum management in the State of Iowa has not developed frequency plans which assures adequate utilization and at the same time minimizes interference. Therefore, in spite of the major trouble with the single frequency channel there are many low-band and high-band VHF channels in use in the state of Iowa. Most of these are under-utilized and therefore are not providing the efficiency which is desired in the frequency management required to conserve spectrum.

Operational facilities for many law enforcement agencies do not have adequate facility security and do not have an ability to operate during power outages. A high percentage of sites do not have emergency power generators and there is generally no standby radio equipment for use if the primary equipments in a base station fail.

There are limited written operational emergency plans and procedures for emergency operation. This tends to indicate that many agencies will improvise when such an emergency occurs. This is not considered satisfactory to meet standards for required law enforcement communications.

Maintenance activities are performed generally by on-call technicians with no contract for their services. In some areas this may be satisfactory, in others a technician may not be available for hours or days during which the equipment remains in an unsatisfactory condition. There is not a uniform criteria available to measure the maintenance service and the resulting equipment performance.

3.2 DESCRIPTION OF DEFICIENCIES

The current system deficiencies can be utilized as a point of reference from which a new system can be designed to provide more reliability and effectiveness in communications for various law enforcement agencies. A digest of deficiencies is summarized in Table 3-1. The deficiencies are largely noted in relationship to the communications channels required in any new system.

Table 3-1 DEFICIENCY LIST - THE CURRENT SYSTEM

PARAMETER	DISCUSSION
Signal Intelligibility: Dead Zones	Base-to-mobile and mobile-to-base dead zones have been cited as a problem for ten percent (10%) of the mail surveyed agencies. The Spectra Radio Communications Prediction Program (SRCPP) has shown these dead zones (Reference 5) to be much more severe due to interference at busy periods. Mobile-to-mobile communications are not satisfactory for seventy two percent (72%) of agencies requiring this mode.
Frequency Interference	Co-frequency interference is most prevalent on 37.10 MHz and both the sheriff and municipal agencies using this frequency have stated that it is a serious problem. The analysis verifies the problems for both mobile-to-base and base-to-mobile links as shown in the Phase I report. Reference 5.
External Electrical Noise	Eleven percent (11%) cited as a problem the time varying interference problem due to the rising noise during electrical storms. Municipal power distribution systems often become noisy during wet weather because of corona and the arcing of underrated or dirty insulators Noise interference produced near a base station can severely limit the mobile-to-base range of a radio system.
Skip Interference	Skip interference typically appears during the summertime on low-band VHF channels. Centrally located, Iowa LEA's have a high probability of interference from stations located in western, southern and sometimes eastern states, and also South and Central American stations. The unwanted signals arrive with very little attenuation and, hence, may capture the rf squelch actuated receiver. Selective squelch coding will reduce the nusiance interference, but will not guard against capture of the receiver rf section, a situation which produces destructive interference.

Channel Utilization:

Efficiency, Interference and Inter-agency

The point-to-point frequency (155.370 MHz) is not used very efficiently nor is it completely implemented for use by all agencies. It is a common practice throughout the state to mute the 155.370 MHz receiver and utilize the 37.10 MHz channel as a "calling channel". These calls unnecessarily increase the interference level on the 37.10 MHz channel. Agencies frequently use the 37.10 MHz channel for point-to-point operations when they have not implemented a 155.37 MHz terminal. Another activity creating a major operational deficiency is the migration of large Iowa cities to the UHF band resulting in a breakdown of the mobile-to-mobile inter-agency link with the county sheriff and neighboring communities. The IPR/IHP move to the VHF HB creates a similar inter-agency cooperation defect. It is timely, hence, that these frequency manuevers be recognized and suitable linkages must be found.

In a similar vein the emergency medical services are developing primary operating channels in the VHF high-band and the low-band link will no longer be available for use with the county sheriff and the many municipal mobiles using low-band.

Channel Utilization Factors

1. Channel overloading in specific agencies is not an apparent problem except on the statewide 37.10 MHz channel. As TRACIS becomes more viable, there will be increased use made of its point-to-point capability for information transfer between departments. There will be an attendant increase in two-way traffic between municipalities and sheriff's departments in the populus counties which typically generate a higher message traffic load. Fortunately many have been able to circumvent the problem of channel overload through a move to multi-channel operations.

2. The underloaded channel is an evident problem as seen from both the on-site and mail survey data. Message traffic rates based on known correlations between population density and police radio and telephone activity shows that only are high population density areas are individual channels operated with an acceptable utilization.

3. Cross band links especially in and near some of the large cities, which can mitigate the problem of inter-agency communications, are missing between agencies operating in different frequency bands. Most noticeable is the inability for accomplishing inter-agency mobile-to-mobile communication. Indirect communications through a dispatcher is a defective solution for the relay of messages between mobile officers who may be attempting to apprehend a violator.

Link Availability

General statewide usage of one frequency for satisfaction of all the radio channel requirements is a serious deficiency in the system. Separate intra-agency mobile-to-mobile Tactical and Information Channels are required in addition to the Operations Channel for intra-agency radio communications.

Facility Utilization Factors:

Dispatch:

1. Full time availability of dispatch was found forty percent (40%) deficient in the agencies responding to the survey. It is also observed that many having 24 hour dispatch may well be providing it under financial stress e.g. should be sharing the cost with other agencies in similar straits. Those agencies which do not now have the capability, of course represent a major deficiency needing correction.

2. Operator overloading is a problem which is found occasionally in the larger city dispatch centers or where the dispatcher is a multi-purpose employee. The deficiency shows up as poor action response time to service requests.

3. Action response time is not recognized generally by most agencies as a problem. However, with channels having severe interference and high traffic density (i.e. 37.10 MHz) there is good reason to conclude that responses in excess of 2 minutes may be expected. Furthermore, there is additional delay for mobile operators who must wait for channel traffic and interference to clear before transmitting for they will not be heard at their base station.

4. An officer and vehicle status board is found in several recently upgraded dispatch centers. Many however, were not functioning properly. This can be a severe handicap in multiple-dispatcher Comm Centers where activity can run very high during peak loads.

5. The duplication of 24 hour dispatch by more than one agency in the same community is commonplace. The deficiency arises in duplication of equipment, records, manpower, (not always well-trained as dispatchers) and in the general duplication of facilities. The major deficiency lies in the economics for facility upgrade and in channel duplication.

Equipment

1. Parallel console. (radio and telephone) equipments were found in twelve percent (12%) of the Law Enforcement Agencies. One console may be located in the general office area and the other in a remote part of the jail or someone's private home. Often this allows the achievement of approximately 24 hour dispatch.

2. A Teletype data system access point is found usually in only larger communities and is not uniformly installed in all county sheriff's or municipal centers. See list of TRACIS terminals in Table 2.3-3 of Reference 5. Access to a nearby Teletype terminal for TRACIS data is not always possible without considerable information relay.

3. Recorder equipment for recording emergency calls and for recording audio received by the radios exists at 9% of the agencies. Those having recorder facilities consider it to be a necessary adjunct to their operations.

Joint Usage

Joint usage of law enforcement base stations communication facilities is presently found in 82 counties. Joint dispatch of police and fire department agencies in the small community appears to be more acceptable than in larger. Deficiencies occur due to inability for inter-agency (law enforcement) communication when the fire department frequency channel is utilized. Cooperative plans for merging county sheriff and county municipal operations are not abundant although encouraging from an operational economy viewpoint. A major deficiency exists because there are too many marginal facilities in the state having inadequate operational capabilities.

Reliability and Security:

Emergency Power

1. Emergency power availability varies considerably. There appears to be concern over the lack of it and most agencies are trying to correct this deficiency as rapidly as possible. The small agencies appear to have difficulty meeting this requirement. Emergency power availability is reported by 22% of municipalities having base stations and 43% of sheriffs with base stations. A deficiency in reliability results at a time when communications are most needed.

Stand-By Equipment

2. Standby transmitter and receiver equipment availability is a relatively rare situation except in large city police departments and in some sheriff's departments. Most rely on placing one mobile into dispatch service until the malfunctioning unit is repaired. Approximately 12% responded that standby transmitting equipment is available. A major deficiency occurs in facilities where there are no secondary radio link equipments.

Facility Security

3. Facility Security: Adequate facility security was found to be lacking predominantly in the small city (20,000 or less). It was especially a problem where the dispatcher had other functions such as city clerk or desk sergeant. For the surveyed facilities, 17% have the antenna tower protected from intrusion and 43% indicated having Comm Center security. In any event, it is estimated that actually less than a third have satisfactory security for the equipment and antenna structure.

Message Security

4. Message security devices are utilized by 5% of the agencies. The main reason for little usage as derived through an on-site question appears to be the ease with which the moderate priced speech scrambler can be decoded with relatively unsophisticated equipment.

Alarm and Signal Controls:

Bank entry alarms are most often found in police department and are typically installed and leased by commercial firms. There is a wide range of displays and varing degrees of reliability. The deficiency is primarily that of a predominance of false alarms and nonstandard indication. False alarms represent a given emergency response.

Auxiliary Operational Requirements:

1. Approximately a third of the responding agencies indicated that written procedures were available in case of disaster and major emergencies. Little indication was found that these were actively reviewed with personnel or that drills were conducted to exercise them.

2. One-fourth of the agencies responding indicated that a training program was in existence for dispatchers. Most programs appeared to be on-the-job training, since a formal training program does not exist. A formal dispatcher training program was almost universally desired by those interviewed.

Maintenance:

Maintenance is typically a function of private service agencies who are frequently associated with one of the major suppliers of two-way radio equipment. Most of the maintenance is provided through an on-call technician with provisions for service, 24 hrs per day. A major deficiency is the lack of satisfactory service quality resulting in substandard system performance.

3.3 PRESENT SYSTEM MODELS

The characteristics of the law enforcement communications systems now operating in Iowa can be described and understood through the use of descriptive models. Several parameters were used heretofore in the report to analyze and describe the present system elements, define future requirements, and show system deficiencies. In this section these same parameters are used in general model configurations to provide a foundation for system upgrade analyses. Models are best used to describe general agency characteristics rather than specific agencies. These characteristics can later be used as a base for performance of improved models evaluation. Several criteria will be established in addition to those of the requirements (Section 2.0) for consistent evaluation throughout the project.

3.3.1 GENERAL MODEL

The Iowa Law Enforcement Communications System can be modeled in terms such as the area signal propagation reliability of municipalities, counties and highway patrol districts of the state. It also can be modeled according to the frequency channels utilized by an aggregate of agencies and through generic link models of the specific agencies which have been described in Section 2.0 of the Phase I Final Report (Reference 5). The data may be evaluated in terms of link operations described in that report. The evaluation of agency communications links is a prime factor in determining the performance of a system. The link functions, operational characteristics, actual response delay and utilization are the most significant elements.

A basic part of link evaluation includes a model of statewide message traffic predicted on the basis of telephone and radio peak busy hour messages per thousand population. The following paragraphs describe the present system in terms of these characteristics and shows a way of evaluation which makes possible relating performance, cost, and overall quality comparisons with the upgraded system implementation plans developed in this Phase Two effort.

3.3.2 AREA/POPULATION RELATIONSHIPS

There are in Iowa fifteen (15) counties which have a population of under ten thousand and there are five (5) which have populations of over one hundred thousand. The seventy nine (79) remaining counties are, of course, intermediate to these extremes. Persons living in each deserve equal law enforcement protection. In a real sense the small population density areas require equal or better communications for generally there are proportionally fewer law enforcement personnel in these areas and they must work more effectively and quickly to assure needed protection. Request for service are made via telephone links either directly to the local police department or to the county sheriff via direct telephone calls or through a telephone operator.

There are over nine hundred cities in Iowa ranging in population from a few dozen to over 200,000. All require occasional law enforcement activity and a reliable means for their citizens to communicate requests for assistance to their law enforcement agency.

In many smaller cities requests for police assistance are called to the sheriff's mobile patrol units to provide surveillance and enforcement in their area. Larger cities can afford a local law enforcement agency and utilize their own police vehicles for rapid response to an emergency call. The radio unit is usually operated on the sheriff's channel.

At some level of size and affluence, a city will install a radio base station, provide dispatchers, will operate more than one vehicle, and will utilize several uniformed personnel who may alternate utilizing a police vehicle or will investigate an incident on foot. As the department size increases, more personnel and vehicles are added.

Radio communications operators may utilize the sheriff's base station under remote control. This is often true of county seat cities for approximately eighty two (82) counties jointly operate this way. Some of the larger county seat cities have their own channel in addition to utilizing the sheriff's channel when joint operations are underway. Larger cities usually provide services and joint operations of their equipment and personnel to the nearby incorporated suburbs.

The sheriff is responsible for a geographical area which in Iowa does not vary from county to county nearly as much as does the population. The ability to finance his operations is dependent upon a tax base which is usually proportional to the population. The number of mobile units and deputies which he can afford also are proportional to population. Communications is generally capable of linking the sheriffs dispatch center to his mobile vehicles, to adjacent county officers, to the Iowa Highway Patrol and to the city law enforcement agencies of the county. Usually there is no present ability for mobile units to contact the sheriff or highway patrol of adjacent states.

3.3.3 AGENCY COMMUNICATIONS CHANNELS

The requirements for law enforcement communications show a need for several types of communications service channels requiring radio frequency links, telephone lines, and data links. The types of channels which are required for various functional communications services were derived from the Requirements Section 2 and are summarized in Table 3-2. All city, county and state law enforcement agencies now utilize each of these types at one time or another. Present services are accomodated on available links. A single radio channel, 37.10 Mhz, is used for all radio channel functions in many agencies.

EMERGENCY REQUEST

The channel providing citizens a way to communicate emergency requests for service is important and must be given high priority in system model evaluation. Presently, in the State of Iowa, this channel functions in the following ways:

1. A telephone link available either through the local telephone company operator by dailing "0" or through a particular agency telephone number listing.
2. Through "911" or a common 7-digit number in certain communities.
3. A dedicated point-to-point line from one public safety or law enforcement agency into another agency.

OPERATIONS

The Operations Channel is the primary service link to mobile and portable units of the agency. It is generally an intra-agency, base-to-mobile, and mobile-to-base voice link. This too is an important channel and its activity, in large communities having a large peak message load, may divide into two or more links, each having a separate frequency. The Operations Channel is utilized for intra-agency dispatch command and control activity and also allows mobile units to report status and location and other administrative messages.

The answering response delay at the dispatch center can be slightly higher than fo the emergency request channel; however, it is usually held to under twenty five (25) seconds. The Comm Center action dispatch delay is within the two (2) minute limit when link support exists.

TACTICAL

The Tactical or Mutual-Aid Channel is needed for emergency mobile-to-mobile coordination and has both a wide inter-agency emergency usage, provided intra-agency mobile-to-mobile communications and requires Comm Center supervision. The existance of this inter-agency Tactical Channel for use between cars of differing jurisdictions is considered the primary service function for this channel. The channel is now served by joint monitoring of the IHPR 42.58 MHz and the local government 37.10 MHz links.

POINT-TO-POINT

Radio Point-to-point Channels are utlized for long range emergency coordination between agencies when common carrier links are out of service or busy or to avoid toll charges.

INFORMATION

The Information Channel is a mobile-to-base radio link from the requesting agency vehicle directly to the dispatcher of the agency having direct information access via a data terminal connected directly into a local, state-wide or national information file. Data responses are provided from base-to-mobile.

Presently, these are voice links; however, digital data usage is growing and eventually will exceed the voice utilization.

The Information Channel usage takes two basic forms:

1) Provide the ability for intra-agency units to request license and criminal information from an area, state, or national data system.
2) Provide the ability of an agency with no terminal to obtain access to this data via an agency having a terminal.

CHANNEL MODEL

Figure 3-1 shows a diagramatic model for the general channels described in the preceding paragraphs and indicates the link(s) required. This generic system diagram shows the relationship of agency usages and inter-agency linkages through use of various channels. Also, it should be evident that a statewide frequency plan is necessary to provide for the radio channels and which will minimize interference between user groups.

3.3.4 FREQUENCY LINK MODELS

Previous sections have described the required channel models for communication between agency base dispatch centers and mobile units, between related agencies and their providing emergency requests and data services. Several related models exist for indication of the utilization of radio communication links in the State of Iowa, presently. The following section describes in summary each of these models with particular emphasis directed toward the methods for performance evaluation.

Generally, the emergency request telephone system is utilized with 7-digit numbers for citizens to call their police or sheriff's office with complaints or emergency requests for service. In many agencies, the emergency and administrative telephone numbers and associated links are not separated and must be processed by personnel as received. Data services are provided via teletype links with interconnections to the state TRACIS computer file. This network is developing a capability for direct teletype typewriter point-to-point services, between agencies of law enforcement, state-wide. Therefore, the principal variation in communication link models is in the radio system frequency links which serve the channel requirements brought forth in the previous section.

Low-Band Single Frequency

Figure 3-1 provides a general diagram for agency intercommunications and represents in a major way, the radio channel activities. In this single frequency model, all of the radio link functions are provided with the single frequency channel. It may generally be assumed that telephone lines provide the emergency request channel and interagency point-to-point communications.

In Iowa the radio frequency used for this link is 37.10 MHz. This link provides all types of service message channels and, in fact, is often used between agency base stations for a Point-to-Point channel. It provides the Operational Channel the mobile-to-mobile, a Tactical (mutual aid intra-inter agency) Channel, the Information and serves itinerant agency operations. In addition, many of the Emergency Medical Service vehicles utilize a sheriff's or municipal police mobile unit cross licensed with the law enforcement agency.

Evaluation for this single frequency link must consider the rate and amount of interference produced when many agencies utilize the same channel for all of their radio communications needs. Also, evaluation recognizes the inability to establish priority and to utilize adequate procedures for efficient operation of a single frequency link serving all channel requirements.

Low-Band Multiple Frequency

The link configuration involves generally the common state-wide radio link of 37.10 MHz for mutual aid and for inter-agency information transfr between Comm Centers and vehicles. The intra-agency operationa coordination and Information Channel activities are provided from a second low-band frequency link which is better defined in Section 2.4.3 of Reference 5. Approximately thirty (30) utilize a second channel consisting of ten (10) low-band links employed on a planned basis for twenty-nine (29) jurisdictions. This operation provides a considerable improvement in reliability and a general ability to establish efficient agency communication channel operations for those agencies using the plan. Generally, the agencies employing this multiple frequency low-band system also utilize a high-band Point-to-point Channel, 155.370 MHz. Emergency Medical Services and Iowa Highway Patrol inter-agency communications are performed on the low-band 37.10 MHz link.

High-Band Single Frequency - Cities:

A single frequency high-band communications system exists in relatively few cities in Iowa. All the required message transfer activity is conducted on a single high-band frequency link much as the activity for the low-band single frequency. The interference level because of low usage is minimal and provides a higher reliability for those communications links, however, it does not provide for inter-agency communications unless both a cross-band monitoring facility is available at the Comm Center and dual frequency radio units are carried in the vehicles. Evaluation of this system must show the disadvantages of having no inter-agency communications.

High-Band Multiple Frequency

This link configuration utilizes more than one frequency link in the VHF high-band law enforcement frequency bands. This link configuration exists in only one county and in four (4) city communications systems at the present time in Iowa. It is a potentially important configuration, for in this operation, inter-agency communication links can be accommodated to the Emergency Medical Services, Iowa Highway Patrol, and for mutual aid to adjacent states' law enforcement agencies without requiring separate mobile radio units in the vehicles of the agencies which utilize this configuration.

This link configuration utilizes a high-band VHF Point-to-Point Channel (155.370 MHz) and for evaluation it may be assumed generally that the emergency request and data services channels exist utilizing common carrier linkages.

UHF Multiple Frequency

In this configuration there is a wide range of link availability for satisfaction of message channel requirements. These do not readily fit into a generic form as presently used. However, the multiple frequency configuration provides an ability for intra-agency operations, coordination, administration or information transfer and for car-to-car tactical frequencies. The UHF configuration does not readily provide for inter-agency communication for there is presently little utilization of UHF by adjacent cities, sheriff's or state law enforcement agencies.

Inter-agency communications in UHF, as in the high-band single frequency system, must depend upon cross-band monitoring and relay through the dispatcher of mobile tactical communications or requires the installation of two (2) mobile equipments.

3.3.5 PREDICTIVE MODEL - MESSAGE LOADING

Models for message traffic loading in both radio channels and telephone emergency request channels is needed to establish a consistent and statistically correct prediction of peak channel message loading for the present traffic and for use in evaluation loading to new system design. This section describes a criteria based upon information from several law enforcement jurisdictions of various population densities in urban and rural areas. (Reference 2). The criteria have been established on the basis of the busy hour peak traffic which might be experienced for the busiest five (5) minutes in a busy hour of the day. Population figures utilized in this report were derived from the Iowa Offical Register, 1971, 1972 (Reference 8).

Table 3-3 is the table of criteria for population based message traffic in terms of categories of population sizes.

TABLE 3-3 POPULATION BASED MESSAGE TRAFFIC

Area Population	Peak Busy Hour Calls per 1,000 Pop.	
	Radio	Telephone
Rural and City < 20K	1.0	0.5
Rural > 20K	1.25	0.75
Cities > 20K < 50K	1.5	1.0
Cities > 50K < 100K	2.0	1.5
Cities > 100K	2.5	2.0

Using these figures it is possible to develop consistent and meaningful utilization factors for the radio links and telephone links for any combination of regional agencies, groups of agencies, or cities and to develop for them a system performance and system design for the area communications centers.

In utilizing the criteria to develop utilization factor for radio messages, it is defined as an exchange of radio transmissions on the same subject. A typical message is ten (10) to twelve (12) seconds in length, if the subject changes during an exchange, a new message is created. If more than five (5) seconds elapse between exchanges, a new message is created. If a message is interrupted by another, a new message is created.

A telephone message primarily refers herein to an emergency complaint or a request for law enforcement service. It is assumed to be one hundred (100) seconds in length.

These criteria are utilized in the report to compute expected busy hour radio and emergency telephone request message densities on the basis of populations of counties and for various population categories of cities within these counties. An important usage is in prediction of the interference expected on the 37.10 MHz channel thus reducing the signal reliability of a county.

Message traffic channel predictions allow for splitting the different channel uses into categories for determining numbers of Operations and Information Channels. Also, the required number of telephone emergency lines may be determined using well-known predictive methods for channel utilization versus numbers of trunks. All these are based on statistical probabilities. The grade of service for meeting requirements can be utilized to determine the number of links in a given channel and the number of telephone links for carrying the required traffic without reducing the grade of service.

Figure 3-2 provides the relationship between the total Comm Center radio system message load and the number of messages per hour which may be handled per channel. Figure 3-3 provides the wait-time for entry of a new message versus the radio system traffic load. Each of these are shown for 1, 2, 3, and 4 channels. Figure 3-4 provides the number of telephone emergency request lines for a wide variation in traffic loading to provide a service grade of 1 busy in 1,000 calls placed. Table 3-4 lists the per county peak traffic loading for both radio channels and telephone emergency requests based upon the predictive model criteria.

3.4 SYSTEM LINK PERFORMANCE

System factors derived in the previous section may be combined to form a general system performance index for evaluation of the present agency systems, i.e. sheriffs or Iowa municipalities, a generic configuration, or a specific agency and for evaluating performance of system implementation plans to be developed in this report. A step by step process for performing this evaluation involves a careful weighing of important system parameters in terms of their importance to the overall system operation. The following section details this method. It can be applied consistently to present and proposed system types based upon the channels they employ and upon operational factors which are known or can be assumed with reasonable accuracy.

1. Channel Parameters and Criteria

(a) Value Weighing - V

The availability of a particular type of service channel can be given an overall value, V. In several generic types of systems a channel may have multiple usage where all message types take their turn with the available service response. For example, the emergency service request channel telephone links may be shared with the administrative channel telephone links. This makes the emergency service lines less available.

A consistent method for evaluation allows a unity value weighing (V=1) for each available channel when its functions are distinctly separated from other operational functions. When two channel functions are shared in the same link e.g. emergency and administrative telephone functions, the value of each is reduced. The total value of each channel can not exceed unity. If a channel function cannot be performed with existing links (i.e. an inter-agency link does not exist) the channel value is non-existing and therefore valued at zero. A link which provides two channel functions must be valued at one-half (1/2) even though it operates perfectly.

b) Response Delay - DR

Each channel will have a particular response delay dependent upon loading. This must be evaluated based upon the priority established for it by the dispatcher or by design criteria. The emergency channel design should meet a fifteen (15) second response delay, maximum. Other channels can have a larger delay but none should exceed thirty (30) seconds. Table 3-5 lists a set of criteria for the parameters involved in channel performance analysis and evaluation.

c) Reliability - R

During the time a telephone or radio link is not in service due to noise, interference, or equipment failure, its performance falls below the required grade of service. We can charge that time to unreliability. There are several contributions to the reduction of the reliability term (R).

A law enforcement system should have a reliability greater than ninety percent (90%) under all conditions. Availability of emergency power, stand-by equipment and links, all contribute to improving the reliability.

Unavailability of a 24 hour dispatch contributes to operational unreliability. A single shift dispatch could have no greater than thirty three percent (33%) reliability, for example. Dispatch reliability R_d for a generic multiple-agency operation consists of the value for one, two, or three (1,2,3) shift operations: One shift; $R_d = .33$, Two shifts; $R_d = .67$, Three shifts; $R_d = 1.0$.

Low-band VHF, during the summer day time hours has a skip interference probability (R_s) of approximately ten percent (10%); therefore R_s = Probability of Skip = 1 - .10 = .90.

Low-band VHF has a precipitation static probability (R_p) of approximately 0.05 which reduces the mobile-to-base signal reliability by fifty percent (50%). $R_p = (1-0.05) = .95$.

A lack of emergency power, standby equipment and other factors can reduce the system reliability to a value of R_e = .95 or more under various conditions.

The total reliability factor (R) is then the product of all the above factors: $R=(R_d)(R_s)(R_p)(R_e)$ for a radio link; $R = (R_d)(R_e)$ for a telephone link.

d) Signal Coverage Reliability - SCR

The radio system base-to-mobile and mobile-to-base signal reliability has been shown in the propagation analysis in Reference 5. For each specific system a quantitative value for the marginal coverage area (MCA) (that area in which the selected grade of service is not met) may be measured. The MCA should not exceed one percent (1%) of the desired coverage area (DCA). Therefore, the ability to evaluate a radio link propagation reliability can provide an additional important factor of link performance. The following formula was developed to reflect low system performance when large relative value of MCA exist. Figure 3-5 shows the behaviour of this SCR with the percent of MCA up to 10% when $SCR = 1-\exp\left[\ .03\ (1-\frac{DCA}{MCA})\ \right]$.

NOTE: The SCR thus evaluated is quite sensitive to the changes in values of MCA: for 1% MCA, the SCR = .95; for 5% MCA, the SCR - .43. This re- reflects the importance of maintaining a small marginal coverage area.

e) Channel Utilization - CU

A system designer must consider a utilization factor, CU, which is the fraction of time a link(s) serving the channel is in use. This factor includes the message rate, the number of messages per hour, and the average length of a message on the links serving the channel. When all these are considered:

1) The Tactical Channel utilization factor for a 10 - 12 seconds message length should not exceed 50% at the peak message rate, (per link).
2) The Operations and Information Channels message rate, for a 12- 15 second message length, should not exceed 63% at the peak message rate.

NOTE: Interference, noise, and traffic all contribute to channel utilization in the sense of link availability and response delay although the factors of interference and noise are included as individual factors in performance evaluations.

3) The data terminal peak utilization should be less than 63% to provide a margin of utility for emergency data file access.

Link utilization, however, is much more subjective as a criterion to evaluate a communications system performance. The utilization is highly dependent upon dispatching procedures and link discipline. It is desireable to have a relatively high peak utilization when a single agency uses the link for any particular traffic type. If the utilization at the busy hour is only a few percent, the link is being under-utilized. Utilization of the link by more than one agency results in interference and increase of MCA to both users. Hence, user agency channel utilization is most important in determining whether or not a given agency requires additional links. The performance index is quantitatively affected through the interference of co-frequency users which relates to the marginal coverage area and in the SCR value.

2. Channel Performance

The formula for channel performance (C_p) combining all the factors derived is: $C_p = (V)\ (DR)\ (R)\ (SCR)$ (Radio links); $C_p = (V)\ (DR)\ (R)$, (Telephone Links). In a Multiple Channel System all channels performance should be evaluated prior to combining into a system performance.

3. System Performance (S_p)

The overall system performance, S_p, can be obtained by evaluating all channels consistently as shown. Upon completion of this, one adds all individual channel performance values and this sum is divided by the number of channels evaluated (N) to obtain the System Performance Value:

$$SP = (CP_1 + CP_2 + CP_3 + \cdots\cdots + CP_N) / N$$

3.5 PRESENT SYSTEM EVALUATION

The evaluation method described in the previous section to achieve a system performance index may be utilized in a reasonably accurate quantitive fashion even though all agencies did not respond uniformly to the questionnaire and therefore all agency characteristics are not known exactly. Specific existence of links for various generic systems is described in terms of the channels which are utilized by agencies. Sheriffs and municipalities have been divided into generic frequency plan categories. (Reference 5.). These categories of links have been described in Section 3.3.4 in terms of the present function of these links.

Data summaries for agencies utilizing the generic systems have been assembled and are used in the channel performance evaluation of the generic (most used) systems. Tables 3-6 and 3-6a summarize the total system performance for various generic systems of Section 3.3.4.

NOTE: Very little information on Point-to-point usage was available from survey form data. The information received from the Iowa Highway Patrol, however, indicates heavy usage of 155.370 MHz in certain areas. Based on these data, we estimate the Point-to-point Channel SCR is less than 0.9.

Tables 3-7, 3-7a through 3-11, 3-11a show the evaluation and theoretical performance of the specific generic systems. The tables designated (a) show the maximum achievable performance of law enforcement communications. Hence, by judicious choice of frequencies, by maintaining adequate emergency lines, by operating an efficient 24 hour dispatch, by proper siting of antennas, and regulation of transmitter output power, by maintaining stand-by power, etc, the theoretical values can be attained with present equipment and techniques. Most of these valued are unity. The notable exception is in low-band communications. Precipitation static and skip reduce the available reliability of a low-band channel to a maximum of .855.

3.6 UPGRADING THE PRESENT SYSTEM

Previous sections have indicated a number of existing system deficiencies and have provided a quantitative method with which to analyze system performance of typical systems (generic). There are a number of problems which need to be solved. Certain of these problems appear to be more urgent than others, and in solving them, there is the possibility of introducing effective solutions for several others.

There are several ramifications in solving the very important inter-agency linkage problem. With the movement to the UHF frequency band of the larger metropolitan areas in the state, combined with the establishment of a high-band frequency system for operations of the Highway Patrol Radio System and with the establishment of the high-band Emergency Medical Services Communications System, there is a rapid trend toward loss of low-band inter-agency communications linkages now available. Several steps must be taken to provide a solution to this problem. It may be required that agency mobile units carry two radio systems, since availability of sufficient new frequency assignments in any one band of the Police Services is limited. The designer of a state-wide communications integration must recognize that all of the present equipment used in the state should not be disposed of immediately for reasons of operations and economy and it is expected that multi-band Operations Channels will continue to be necessary. The development must be provided with acceptable frequency plans providing sufficient frequencies for the required Operations, Information, Tactical and Wide-Area radio channels.

The development of a satisfactory frequency plan in the VHF low-band will allow mitigation of the serious operational reliability problem in the state-wide 37.10 MHz common usage channel.

Acceptance of a nationwide Tactical Channel on 155.475 MHz makes feasible use of the VHF high-band frequency assignments for other channel functions and offers possibilities for restoration of inter-agency communications on a broad scale.

Many communication facilities now utilize only a single shift, although many do have the 24 hour/7 day dispatch required to meet law enforcement communications system command and control standards. Low population density areas of the state produce a small message traffic and even a county-wide consolidation of all law enforcement communications usually does not creat a sufficient message traffic load and related activities for desirable minimum frequency channel utilization. As a consequence, much can be saved in annual operating costs, as well as in capital equipment, by consolidating facilities into a single county Communications Center.

Consolidation of facilities within a single county could meet the criterion of an adequate channel utilization in approximately seventeen counties in Iowa. Table 3-12 lists these counties. A message traffic criterion value for total radio channel utilization should exceed a minimum of the counties, the combined county and city message traffic load is greater than approximately one hundred fifty (150) per hour (0.50 utilization). Therefore, those Comm Centers will require more than one dispatcher position and the base station equipment must be capable of handling more than one frequency link for each of the Operations and Information Channels. In counties with cities having greater than 50,000 population, it is reasonably economical to have a separate city and county Comm Center, although the yearly operational costs can be considerably reduced by combined operations in these larger cities.

Consolidation of facilities must consider the ability to communicate readily and rapidly on both intra and inter-agency channels. There must be a capability for the radio system to provide reliable communications for base-to-base and mobile-to-base Operations and Information Channels and in addition, meet the Wide-Area mobile-to-mobile communications range requirement.

Estimated annual operational costs for dispersed, consolidated, and regional Comm Centers are shown in Table 3-13.

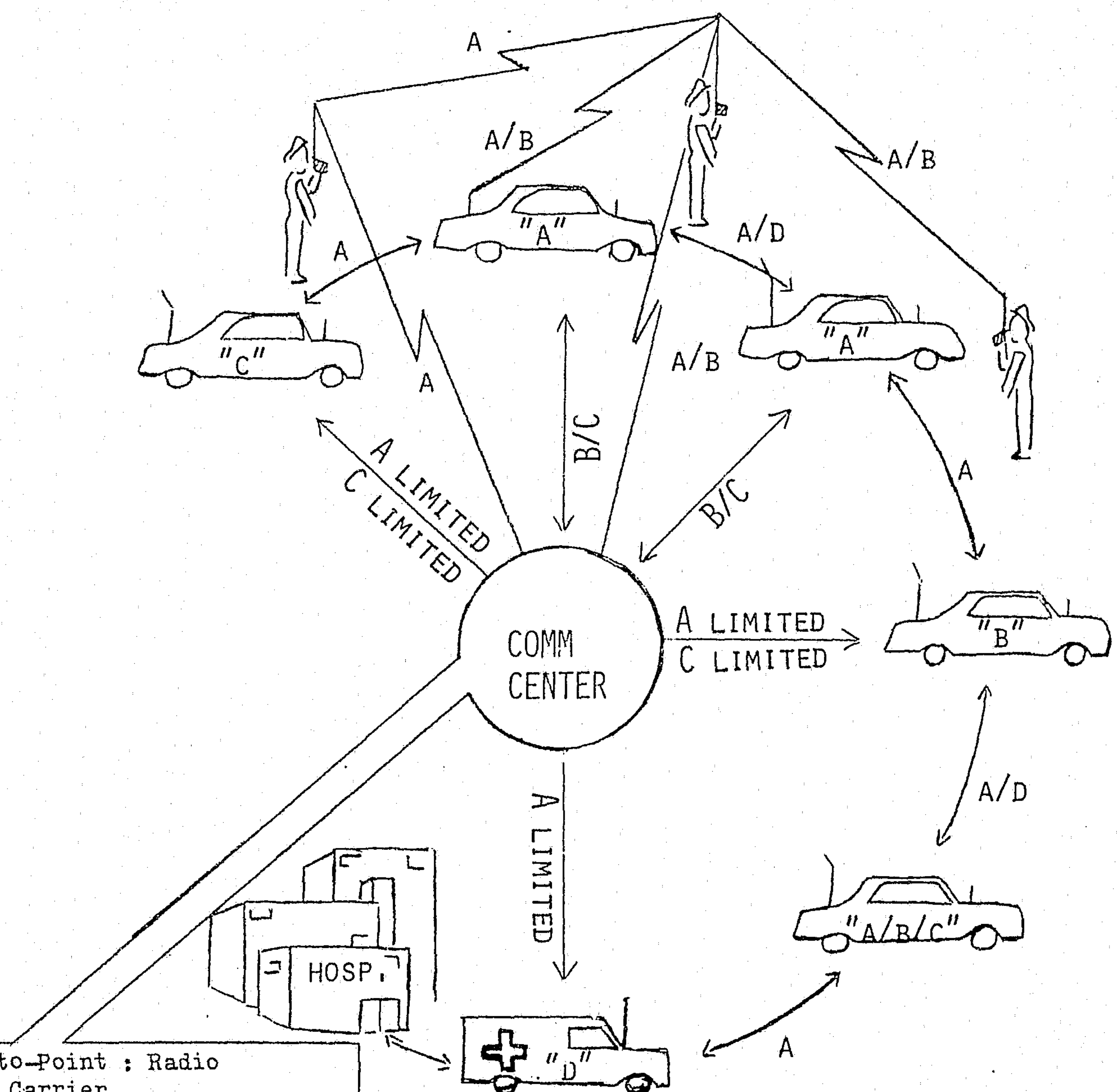
(1) The dispersed costs are estimated on the basis of establishing upgraded Comm Centers in each of the county and city agencies now dispatching law enforcement units.

(2) The consolidated costs are based on there being a single Comm Center for all law enforcement dispatch within a county, but does not include those counties in which cities with populations greater than 50,000 are located. In this latter case, it is assumed that these cities will have Opearations/Information Channels in a Comm Center seperate from the consolidated county Comm Center.

(3) The regional yearly costs assume an individual Comm Center for each of the thirty-two (32) regions shown in the frequency plan of Section 4.0.

The operational costs shown in Table 3-13 include the costs estimated for dispatcher and supervisor salaries, overhead, telephone (emergency only), data terminal lease and equipment maintenance.

The estimates are based upon average figures, the magnitude may be in error by 25%, however, the ratios are quite meaningful, for each of the three operating systems is consistently evaluated with respect to the other. Each of the upgrade consolidations is a significant improvement, the regional system offers a vast operational cost savings and will doubtlessly be attractive to many agencies whose desire for operational efficiency will transcend the subjective fears of loss of identity.



Point-to-Point : Radio
Common Carrier
Communication Links

Radio: Point-to-Point Inter Agency
Telephone Lines:
- Public Complaint/Request
- Outgoing Interagency
- Dedicated "hot-lines"
- Data (TRACIS, LETS, NCIC, LENCIR, etc)
- Remote Control for Base Stations or microwave

RADIO COMMUNICATIONS

1. Mobile / Portable Units
   - "A" - Own Agency
   - "B" - Adjacent agency
   - "C" - Statewide or Itenerant agency
   - "D" - Ambulance
2. Radio B-M / M-B Channels
   - A - Tactical (Mutual Aid) Inter-Intra Agency
   - B - Operations
   - C - Information
   - D - Wide Area

FIGURE 3-1

GENERIC SYSTEM FOR (agency) GENERAL LEA LINK DIAGRAM

OPERATING ON (frequency) VARIOUS

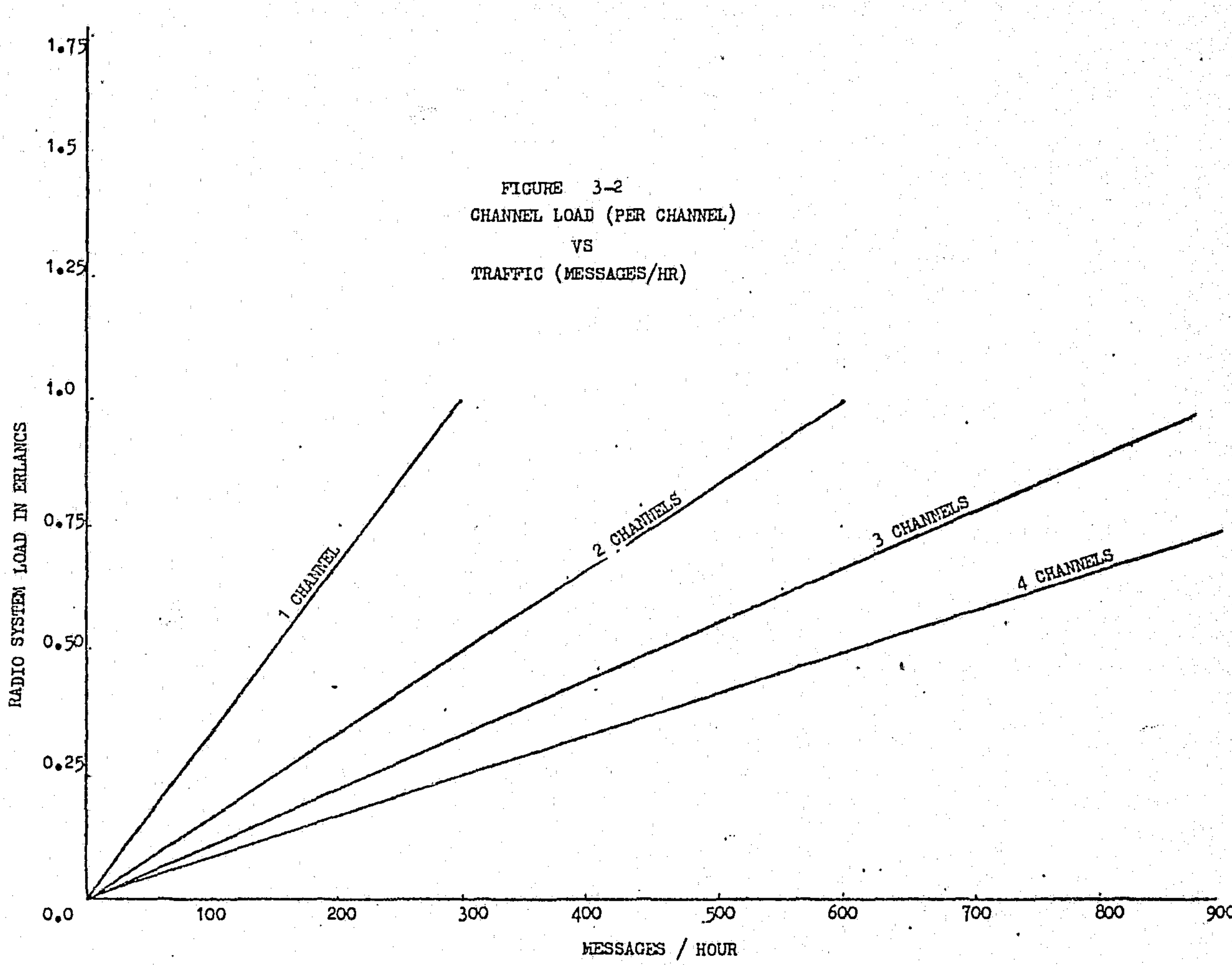


FIGURE 3-2
CHANNEL LOAD (PER CHANNEL)
VS
TRAFFIC (MESSAGES/HR)

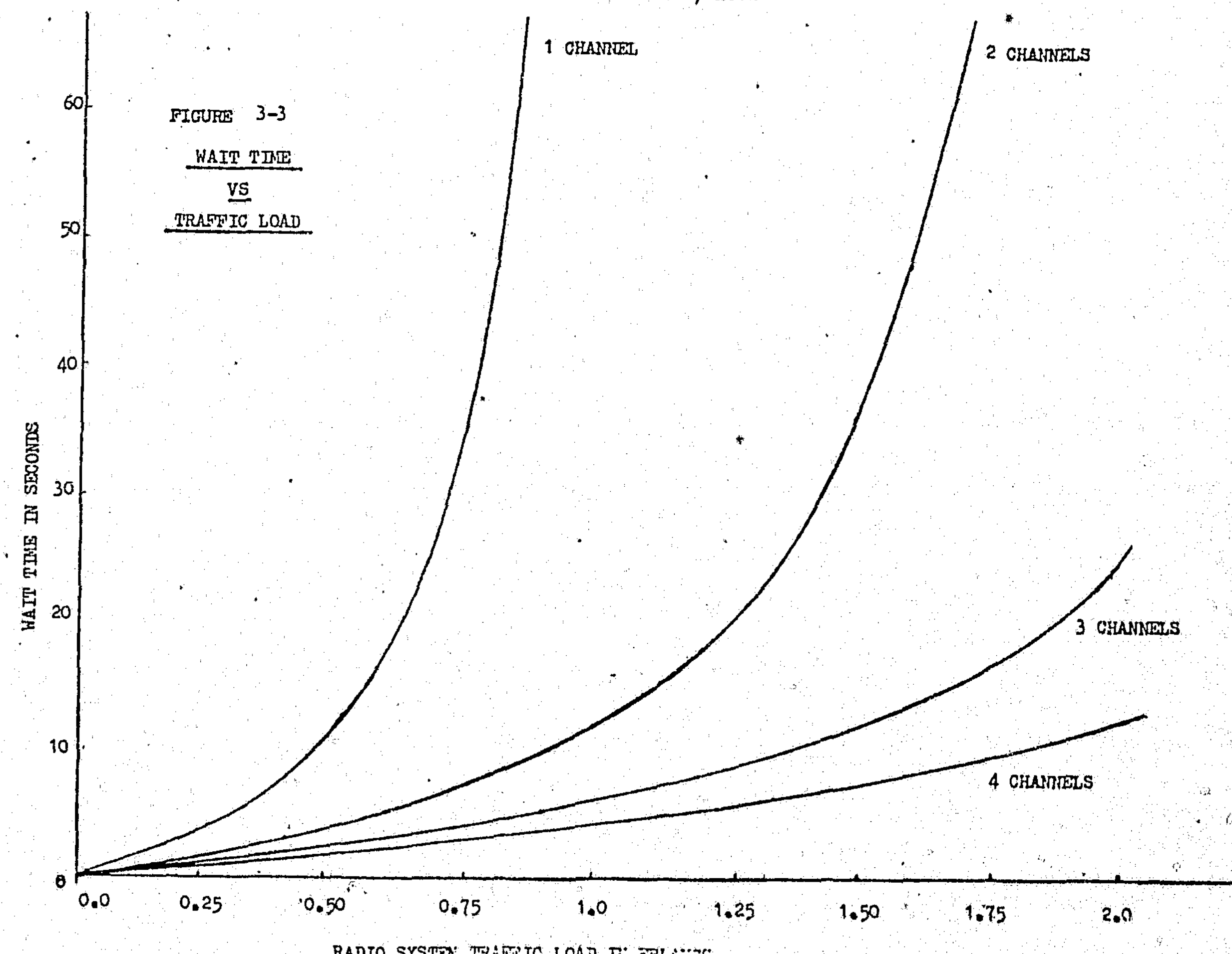
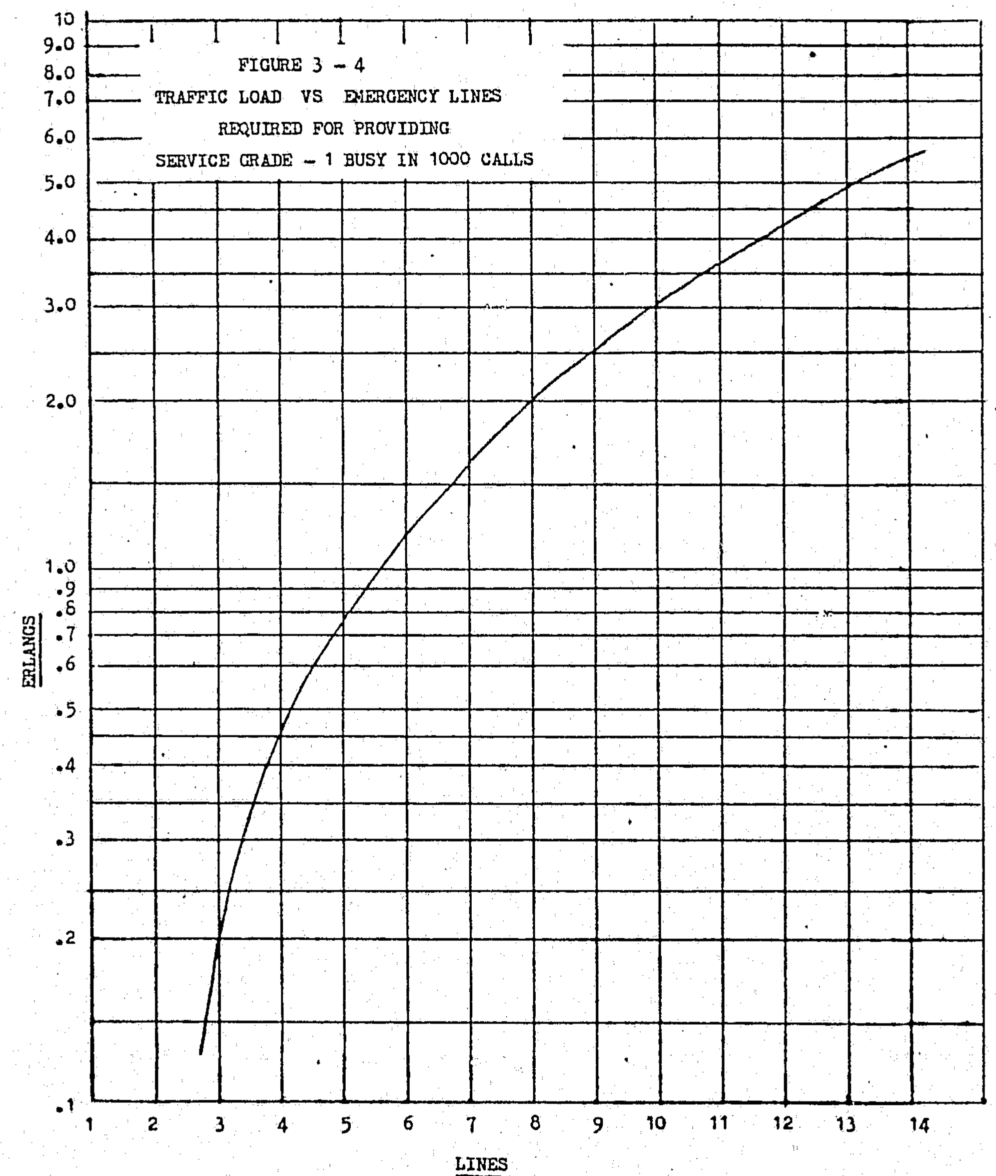


FIGURE 3-3
WAIT TIME
VS
TRAFFIC LOAD



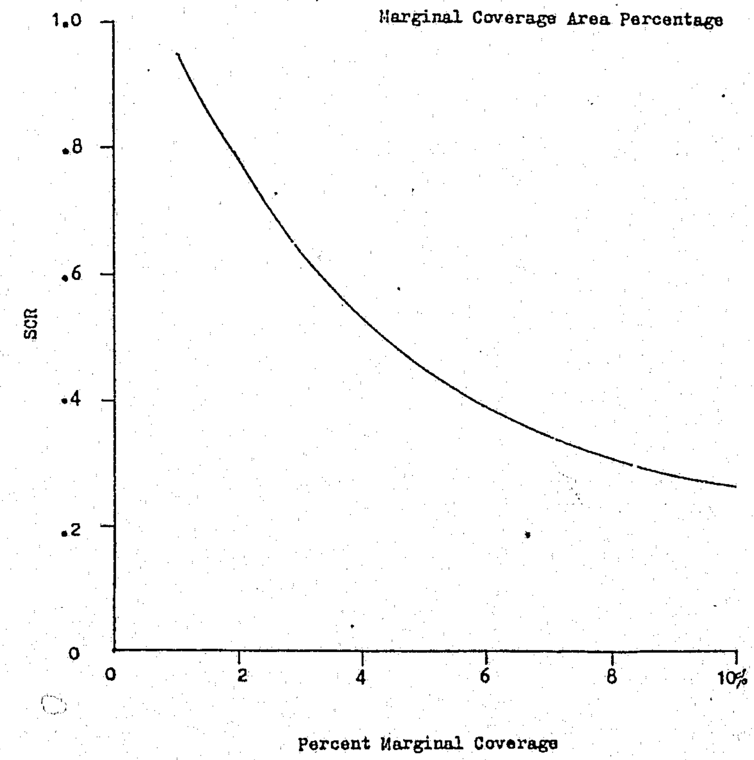


FIGURE 3-5

System Coverage Reliability (SCR)

Versus

Marginal Coverage Area Percentage

Table 3-2 CHANNEL DESCRIPTIONS

TYPE OF SERVICE CHANNEL	LINK EQUIPMENT	MESSAGE FLOW
1. Emergency Requests:	Telephone Dedicated Point-to-point	Public to Comm Center
Requests for Assistance Complaints, Referrals	(Voice), 911, Dial "O" Operator	Inter-Agency SH NM EMS IPR
2. Operational (primary service channel)	Radio (Voice)	Intra-agency B-M/ M-B, Personal Portab
3. Tactical (Mutual Aid)	Radio (Voice)	Personal Portable Intra-agency, SH, PD
a) Intra-agency	Radio (Voice)	M-M Intra-agency, SH
b) Inter-agency	Radio (Voice)	M-M Inter-agency, NM IH EM
4. Inter-agency	Telephone, Radio TTY Point-to-point (Voice)	Inter-agency
5. a) Information Access	Radio (Voice)(Data)	Inter-Intra-agency,
	TTY	Inter-agency
	Telephone & Point-to-Point (Voice)(Data)	Inter-agency NM IPR SH IPR NM
b) Data File Access	Data Link (TTY, CRT, etc.)	

PD	=	Own Police Dept.	IPR	=	Iowa Police Radio
TTY	=	Teletype, Teleprinters	LG	=	Local Government
SH	=	Sheriff	NM	=	Nearby Municipalities
IHP	=	Iowa Highway Patrol	EMS	=	Emergency Medical Services
M-M	=	Mobile-to-mobile	B-M	=	Base-to-Mobile
M-B	=	Mobile-to-Base			

Table 3-4 PREDICTED PEAK TRAFFIC LOADING - PER COUNTY

County No.	County Name	County Pop	Urban Pop	Rural Pop	Tele Calls per/hr. Rural	Urban	Total	Radio Mess. Per/hr. Rural	Urban	Total
1	Adair	9,487	-	9,487	5.0	-	5.0	9.5	-	9.5
2	Adams	6,322	-	6,322	3.0	-	3.0	6.3	-	6.3
3	Allamakee	14,968	-	14,968	7.5	-	7.5	15.0	-	15.0
4	Appanoose	15,007	-	15,007	7.5	-	7.5	15.0	-	15.0
5	Audubon	9,595	-	9,595	4.8	-	4.8	10.0	-	10.0
6	Benton	22,885	-	22,885	17.2	-	17.2	28.6	-	28.6
7	Black Hawk	132,916	105,130	27,786	20.8	210	230.8	34.7	262	296.7
8	Boone	26,470	-	26,470	19.8	-	19.8	33.1	-	33.1
9	Bremer	22,737	-	22,737	17.1	-	17.1	28.4	-	28.4
10	Buchanan	21,746	-	27,746	20.8	-	20.8	34.7	-	34.7
11	Buena Vista	20,693	-	20,693	15.5	-	15.5	25.9	-	25.9
12	Butler	16,953	-	16,953	8.5	-	8.5	17.0	-	17.0
13	Calhoun	14,287	-	14,287	7.2	-	7.2	14.0	-	14.0
14	Carroll	22,912	-	22,912	17.2	-	17.2	28.6	-	28.6
15	Cass	17,007	-	17,007	8.5	-	8.5	17.0	-	17.0
16	Cedar	17,655	-	17,655	8.8	-	8.8	18.0	-	18.0
17	Cerro Gordo	49,335	30,491	18,844	9.4	45	54.4	19.0	46	65.0
18	Cherokee	17,269	-	17,269	8.6	-	8.6	17.0	-	17.0
19	Chickasaw	14,969	-	14,969	7.5	-	7.5	15.0	-	15.0
20	Clarke	7,581	-	7,581	3.8	-	3.8	8.0	-	8.0
21	Clay	18,464	-	18,464	9.2	-	9.2	19.0	-	19.0
22	Clayton	20,606	-	20,606	15.5	-	15.5	25.8	-	25.8
23	Clinton	56,749	34,719	22,030	16.5	53	69.5	27.5	52	79.5
24	Crawford	19,116	-	19,116	9.6	-	9.6	19.0	-	19.0
25	Dallas	26,085	-	26,085	19.6	-	19.6	32.6	-	32.6
26	Davis	8,207	-	8,207	4.1	-	4.1	9.0	-	9.0
27	Decatur	9,737	-	9,737	4.8	-	4.8	10.0	-	10.0
28	Delaware	18,770	-	18,770	9.4	-	9.4	19.0	-	19.0
29	Des Moines	46,982	32,366	14,616	7.3	32	39.3	15.0	48	63.0
30	Dickinson	12,565	-	12,565	6.3	-	6.3	13.0	-	13.0
31	Dubuque	90,309	62,309	28,300	21.2	124	145.2	35.4	125	160.4
32	Emmet	14,009	-	14,009	7.0	-	7.0	14.0	-	14.0
33	Fayette	26,898	-	26,898	20.2	-	20.2	33.6	-	33.6
34	Floyd	19,860	-	19,860	10.0	-	10.0	20.0	-	20.0
35	Franklin	13,255	-	13,255	7.0	-	7.0	13.0	-	13.0
36	Fremont	9,282	-	9,282	5.0	-	5.0	10.0	-	10.0
37	Greene	12,716	-	12,716	7.0	-	7.0	13.0	-	13.0
38	Grundy	14,119	-	14,119	7.0	-	7.0	14.0	-	14.0
39	Guthrie	12,243	-	12,243	6.0	-	6.0	12.0	-	12.0
40	Hamilton	18,383	-	13,383	9.0	-	9.0	18.0	-	18.0
41	Hancock	13,330	-	13,330	7.0	-	7.0	13.0	-	13.0
42	Hardin	22,248	-	22,248	16.7	-	16.7	27.8	-	27.8
43	Harrison	16,240	-	16,240	8.0	-	8.0	16.0	-	16.0
44	Henry	18,114	-	18,114	9.0	-	9.0	18.0	-	18.0
45	Howard	11,442	-	11,442	6.0	-	6.0	11.0	-	11.0
46	Humboldt	12,519	-	12,519	7.0	-	7.0	13.0	-	13.0
47	Ida	9,190	-	9,190	5.0	-	5.0	10.0	-	10.0
48	Iowa	15,419	-	15,419	8.0	-	8.0	15.0	-	15.0
49	Jackson	20,839	-	20,839	15.6	-	15.6	21.0	-	21.0
50	Jasper	35,425	-	35,425	26.6	-	26.6	44.3	-	44.3

Table 3-4 Cont.

County No.	County Name	County Pop.	Urban Pop.	Rural Pop.	Tele Calls per/hr. Rural	Urban	Total	Radio Mess per/hr. Rural	Urban	Total
51	Jefferson	15,774	-	15,774	8.0	-	8.0	16.0	-	16.0
52	Johnson	72,127	46,850	25,277	18.9	37.	55.9	31.6	70	101.6
53	Jones	19,868	-	19,868	10.0	-	10.0	20.0	-	20.0
54	Keokuk	13,943	-	13,943	7.0	-	7.0	14.0	-	14.0
55	Kossuth	22,937	-	22,937	17.2	-	17.2	28.7	-	28.7
56	Lee	42,996	28,627	14,369	7.0	29	36.0	14.0	43	57.0
57	Linn	163,213	128,670	34,543	29.9	257	286.9	43.2	322	365.2
58	Louisa	10,682	-	10,682	5.0	-	5.0	11.0	-	11.0
59	Lucas	16,163	-	16,163	8.0	-	8.0	16.0	-	16.0
60	Lyon	13,340	-	13,340	7.0	-	7.0	13.0	-	13.0
61	Madison	11,558	-	11,558	6.0	-	6.0	12,0	-	12.0
62	Mahaska	22,177	-	22,177	16.6	-	16.6	27.7	-	27.7
63	Marion	26,352	-	23,352	17.5	-	17.5	29.2	-	29.2
64	Marshall	41.076	26,219	14,857	8.0	26	34.0	15.0	39	54.0
65	Mills	11,606	-	11,606	13.0	-	13.0	12.0	-	12.0
66	Mitchell	13,108	-	13,108	14.0	-	14.0	13.0	-	13.0
67	Monona	12,069	-	12,069	9.0	-	9.0	12.0	-	12.0
68	Monroe	9,357	-	9,357	11.0	-	11.0	9.0	-	9.0
69	Montgomery	12,781	-	12,781	6.0	-	6.0	13.0	-	13.0
70	Muscatine	37,181	22,405	14,776	7.0	11	18.0	15.0	34	49.0
71	O'Brien	17,522	-	17,522	9.0	-	9.0	18.0	-	18.0
72	Osceola	8,555	-	8,555	5.0	-	5.0	9.0	-	9.0
73	Page	18,507	-	18,507	9.0	-	9.0	19.0	-	19.0
74	Palo Alto	13,289	-	13,289	7.0	-	7.0	13.0	-	13.0
75	Plymouth	24,312	-	24,312	18.2	-	18.2	30.4	-	30.4
76	Pocahontas	12,729	-	12,729	7.0	-	7.0	13.0	-	13.0
77	Polk	286,101	242,154	43,947	33.0	484	517.0	54.9	605	659.9
78	Pottawattamie	86,991	60,348	26,643	20,0	91	111.0	33.3	121	154.3
79	Poweshiek	18,803	-	18,803	9.0	-	9.0	19.0	-	19.0
80	Ring Gold	6,373	-	6,373	3.0	-	3.0	6.0	-	6.0
81	Sac	15,573	-	15,573	8.0	-	8.0	16.0	-	16.0
82	Scott	142,687	120,595	22,092	15.6	241	256.6	27.6	302	329.6
83	Shelby	15,528	-	15,528	8.0	-	8.0	16.0	-	16.0
84	Sioux	27,996	-	27,996	21.0	-	21.0	35.0	-	35.0
85	Story	62,783	39,505	23,278	17.5	40	57.5	29.1	59	88.1
86	Tama	20,147	-	20,147	15.1	-	15.1	20.0	-	20.0
87	Taylor	8,790	-	8,790	5.0	-	5.0	9.0	-	9.0
88	Union	13,557	-	13,557	7.0	-	7.0	14.0	-	14.0
89	Van Buren	8,643	-	8,643	5.0	-	5.0	9.0	-	9.0
90	Wapello	42,149	29,610	12,539	6.0	15	21.0	13.0	44	57.0
91	Warren	27,432	-	27,432	20.6	-	20.6	34.3	-	34.3
92	Washington	18,967	-	18,967	10.0	-	10.0	19,0	-	19.0
93	Wayne	8,405	-	8,405	4.0	-	4.0	8.0	-	8.0
94	Webster	48,391	31,263	17,128	9.0	31	40.0	17.0	47	64.0
95	Winnebago	12,990	-	12,990	7.0	-	7.0	13.0	-	13.0
96	Winneshiek	21,758	-	21,758	16.3	-	16.3	27.2	-	27.2
97	Woodbury	103,052	85,925	17,127	8.0	129	137.0	17.0	172	189.0
98	Worth	8,968	-	8,968	5.0	-	5.0	9.0	-	9.0
99	Wright	17,294	-	17,294	9.0	-	9.0	18.0	-	18.0

Table 3-5

CHANNEL ANALYSIS CRITERIA

Channel Type	Channel Value	Max Response Delay Seconds	Max Utilization	Min Reliability	Maximum Allowable Signal Marginal Coverage (Percent)
All Links are Radio Unless Otherwise Indicated.					
Emergency Request (Telephone)	1	15 Sec.	0.5	.90	
Operational (primary M-B, B-M working channel)	1	25	0.63	.90	1%
Tactical: (Mutual Aid)					
a) Inter-agency	$\frac{1}{2}$*	15	0.50	.90	1%
b) Intra-agency	$\frac{1}{2}$*	15	0.50	.90	1%
Inter-Agency	$\frac{1}{2}$ for P-T-P radio	30	0.63	.90	1%
	$\frac{1}{2}$ for Telephone	30	0.63	.90	
Information:					
a) Intra/Inter-Agency	$\frac{1}{2}$*	25	0.63	.90	1%
b) Data Link Term (TTY, CRT, etc.)	$\frac{1}{2}$*			.90	

* Total channel value is 1 if links exist for separate channel functions.

Table 3-6

SYSTEM PERFORMANCE EVALUATION SUMMARY

	Low-Band Single Freq.	Low-Band Mult Freq.	High-Band Single Freq.	High-Band Mult * Freq.	UHF**
Emergency Request (Telephone)	.49	.692	.396	.771	.99
Operational (Radio)	.025	.723	.724	.701	.99
Mutual-Aid Tactical (Radio)	.022	.061	0.0	.662	.99
Inter-Agency	.729	.624	.574	.511	.65
Information/Data	.49	.572	.522	.613	.891
Total System Performance	.351	.534	.443	.652	.902

* Based on three (3) complete reports

** Based on four (4) complete reports

Table 3-6a

THEORETICAL SYSTEM PERFORMANCE SUMMARY

	Low-Band Single Freq.	Low-Band Mult Freq.	High-Band Single Freq.	High-Band Mult Freq.	UHF Multi. Freq.
Emergency Request	1.0	1.0	1.0	1.0	1.0
Operational (Radio)	.423	.855	.5	1.0	1.0
Mutual-Aid Tactical (Radio)	.423	.855	.5	1.0	1.0
Inter-Agency	1.0	1.0	1.0	1.0	1.0
Information/Data	1.0	1.0	1.0	1.0	1.0
Total System Performance	.769	.942	.80	1.0	1.0

Table 3-7 PERFORMANCE EVALUATION SINGLE FREQUENCY LOW-BAND

Channel Type	Channel Value (V)	Response Delay (R_D)	Factors Reliability (R)	Signal coverage Reliability (SCR)	Total Channel Performance
Emergency Request (Telephone)	.671	.802	.91	—	.49
Operational (Primary M-B, B-M working channel)	.402	.919	.782	.086	.025
Tactical (Mutual Aid)	.402	.802	.782	.086	.022
Inter-Agency	.835	.955	.91	—	.729
Information:	.59	.919	.91	—	.49
			System Performance Index		.351

Table 3-7(a) THEORETICAL PERFORMANCE EVALUATION SINGLE FREQUENCY LOW - BAND

Channel Type	Channel Value (V)	Response Delay (R_D)	Factors Reliability (R)	Signal coverage Reliability (SCR)	Total Channel Performance
Emergency Request (Telephone)	1.0	1.0	1.0	—	1.0
Operational (Primary M-B, B-M working channel)	.5	1.0	.855	1.0	.423
Tactical (Mutual Aid)	.5	1.0	.855	1.0	.423
Inter-Agency	1.0	1.0	1.0	1.0	1.0
Information:	1.0	1.0	1.0	1.0	1.0
			System Performance Index		.769

Table 3-8 PERFORMANCE EVALUATION MULTIPLE FREQUENCY LOW-BAND

Channel Type	Channel Value (V)	Response Delay (R_D)	Factors. Reliability (R)	Signal coverage Reliability (SCR)	Total Chan. Performance
Emergency Request (Telephone)	.84	.922	.893	—	.692
Operational (Primary M-B, B-M working channel)	1.0	.956	.764	.998	.723
Tactical (Mutual Aid)	1.0	.922	.764	.086	.061
Inter-Agency	.72	.969	.894	—	.624
Information	.66	.969	.894	—	.572
			System Performance Index		.534

Table 3-8(a) THEORETICAL PERFORMANCE EVALUATION MULTIPLE FREQUENCY LOW-BAND

Channel Type	Channel Value (V)	Response Delay (R_D)	Factors. Reliability (R)	Signal coverage Reliability (SCR)	Total Chan. Performance
Emergency Request (Telephone)	1.0	1.0	1.0	—	1.0
Operational (Primary M-B, B-M working channel)	1.0	1.0	.855	1.0	.855
Tactical (Mutual Aid)	1.0	1.0	.855	1.0	.855
Inter-Agency	1.0	1.0	1.0	1.0	1.0
Information	1.0	1.0	1.0	1.0	1.0
			System Performance Index		.942

Table 3-9 PERFORMANCE EVALUATION MULTIPLE FREQUENCY HIGH-BAND *

Channel Type	Channel Value (V)	Response Delay (R_D)	Reliability (R)	Signal coverage Reliability (SCR)	Total Channel Performance
	Factors				
Emergency Request (Telephone)	1.0	.944	.817	—	.771
Operational (Primary M-B, B-M working channel)	1.0	1.0	.817	.858	.701
Tactical (Mutual Aid)	1.0	.944	.817	.858	.662
Inter-Agency	.625	1.0	.817	—	.511
Information:	.75	1.0	.817	—	.613
			System Performance Index		.652

* Complete data available for only three agencies

Table 3-9(a) THEORETICAL PERFORMANCE EVALUATION MULTIPLE FREQUENCY HIGH-BAND

Channel Type	Channel Value (V)	Response Delay (R_D)	Reliability (R)	Signal coverage Reliability (SCR)	Total Channel Performance
	Factors				
Emergency Request (Telephone)	1.0	1.0	1.0	—	1.0
Operational (Primary M-B, B-M working channel)	1.0	1.0	1.0	1.0	1.0
Tactical (Mutual Aid)	.5 (1.0)*	1.0	1.0	1.0	.5 (1.0)
Inter-Agency	1.0	1.0	1.0	1.0	1.0
Information:	1.0	1.0	1.0	1.0	1.0
			System Performance Index		.9 (1.0)

* Figures are based on IHP and EMS on low-band; hence, high-band agencies do not have mutual aid contact unless they carry low-band equipment. Figures in parentheses indicate values when IHP and EMS are both high-band.

Table 3-10 PERFORMANCE EVALUATION SINGLE FREQUENCY HIGH-BAND

Channel Type	Channel Value (V)	Factors Response Delay (R_D)	Reliability (R)	Signal coverage Reliability (SCR)	Total Chann Performance
Emergency Request (Telephone)	.571	.9*	.770	—	.396
Operational (Primary M-B, B-M working channel)	1.0	.95*	.762	1.0	.724
Tactical (Mutual Aid)	0.0	—	—	—	0.0
Inter-Agency	.786	.95*	.770	—	.574
Information:	.714	.95*	.770	—	.522
			System Performance Index		.443

* Estimate — only two agencies reported data

Table 3-10(a) THEORETICAL PERFORMANCE EVALUATION SINGLE FREQUENCY HIGH-BAND

Channel Type	Channel Value (V)	Factors Response Delay (R)	Reliability (R)	Signal coverage Reliability (SCR)	Total Chann Performance
Emergency Request (Telephone)	1.0	1.0	1.0	—	1.0
Operational (Primary M-B, B-M working channel)	0.5	1.0	1.0	1.0	0.5
Tactical (Mutual Aid)	0.5	1.0	1.0	1.0	.5
Inter-Agency	1.0	1.0	1.0	1.0	1.0
Information:	1.0	1.0	1.0	1.0	1.0
			System Performance Index		.8

Table 3-11 PERFORMANCE EVALUATION MULTIPLE FREQUENCY UHF *

Channel Type	Factors: Channel Value (V)	Response Delay (R_D)	Reliability (R)	Signal coverage Reliability (SCR)	Total Channel Performance
Emergency Request (Telephone)	1.0	1.0	.99	—	.99
Operational (Primary M-B, B-M working channel)	1.0	1.0	.99	1.0	.99
Tactical (Mutual Aid) a) Intra - agency b) Inter - agency	1.0	1.0	.99	1.0	.99
Inter-Agency	.6	1.0	.99	—	.65
Information:	.9	1.0	.99	—	.891
			System Performance Index		.902

* Complete data available for only four agencies

Table 3- 11(a) THEORETICAL PERFORMANCE EVALUATION MULTIPLE FREQUENCY UHF (Municipal)

Channel Type	Factors: Channel Value (V)	Response Delay (R_D)	Reliability (R)	Signal coverage Reliability (SCR)	Total Channel Performance
Emergency Request (Telephone)	1.0	1.0	1.0	—	1.0
Operational (Primary M-B, B-M working channel)	1.0	1.0	1.0	1.0	1.0
Tactical (Mutual Aid)	1.0*	1.0	1.0	1.0	1.0
Inter-Agency	1.0	1.0	1.0	1.0	1.0
Information:	1.0	1.0	1.0	1.0	1.0
			System Performance Index		1.0

* Assumes necessary inter-agency mutual-aid channel exists (UHF agencies <u>must</u> carry two mobile radio units to maintain mutual-aid capability).

Table 3-12 COUNTIES HAVING FULL CHANNEL UTILIZATION (RADIO)

County No.	Co. Name	Peak Radio Message/Hour
7	Blackhawk	289
17	Cerro Gordo	65
23	Clinton	74
29	Des Moines	63
31	Dubuque	154
52	Johnson	96
56	Lee	57
57	Linn	357
64	Marshall	54
7	Muscatine	49
77	Polk	649
78	Pottawattamie	148
82	Scott	324
85	Story	82
91	Wappello	57
94	Webster	64
97	Woodbury	189

Table 3-13 ESTIMATED OPERATIONAL COSTS PER YEAR - DISPERSED SYSTEM, COUNTY SYSTEM AND REGIONAL SYSTEM UPGRADE

(Counties with Cities >50,000 are not included)

	Present Dispersed	Consolidated County	Regional
Cost Per Year	$ 15,970,000	$13,200,000	$ 5,500,000
Ratio to Present System Upgrade	100%	82.65%	34.4
Potential Saving	0	$ 2,770,00	$10,400,000

4.0 SYSTEM DESIGN CRITERIA, PERFORMANCE PREDICTION AND EVALUATION

The design criteria on which the planning for these communications systems is based have a real relationship to the needs of the state, county, and city agencies involved. In establishing the design criteria for the upgrade of the present systems operation and equipment, the objectives of the program must be detailed. A summary of these objectives forms the necessary background for understanding the planned way specific system functions are related to each other and integrate into the operation of a state-wide law enforcement communications system.

Basic county/city implementation objectives are listed with full realization of the operational and economic advantages of further consolidation into a regional communications system plan. Summary detail is provided to show the direction taken to achieve this system design.

1. Implementation Plan Objectives to Integrate and Upgrade the Present System

    a. The development of a system plan based on required performance factors consistent with lowest cost.
    b. Effective utilization of existing communications facilities.
    c. An open-end county-wide system into which technical improvements may be incorporated and system expansion toward regional consolidation is technically and exonomically feasible.
    d. Compatible with and meets requirements of various funding agencies.
    e. Improved communications equipment and siting plans for consolidation and upgrade of the best communications facility and to develop it into the county Comm Center.
    f. Facility plans for base/mobile/portable and Point-to-Point radio communications links.
    g. Coordination of state, county, municipal and private facilities which cooperate in law enforcement activities and inter-agency communications.
    h. Form adjacent county groupings which have an aggregate population greater than 35,000 persons. With these groups, form a state-wide frequency plan so that channel utilization is maximized and interference is minimal.

i. Form regional groupings in which radio transmission and reception can meet the required grade of service for mobile-to-base, base-to-mobile, and for portable unit operations. Indicate site coordinates for base stations and remote bases to assure that this grade of service will be met.

j. Develop and recommend Comm Center management plans to assure that integrated operations satisfy national standards for procedures, training, management, frequency usage, performance and will have the necessary financial support to sustain long term Comm Center operations satisfactory to all user agencies.

k. Provide recommendations for county population centers and certain integrated regions to establish a single number emergency request system for the public, preferably the "911" system.

2. Future System Expansion/Growth Objectives

Provide for the further upgrade and regional consolidation of existing law enforcement communications systems which meet the approved requirements and have the following expansion possibilities.

a. Computer control of communications facilities and information systems (TRACIS , computer aided dispatch, etc.),

b. Communications with air-borne vehicles,

c. Automated electronic display of vehicle status and geographical location,

d. Emergency reporting facility improvements in large areas similar to or incorporating the capability of the single universal emergency telephone number "911" request system.

e. Data transmission of information both intra-agency/inter-agency.

An important objective in planning involves organization of the various required functional categories of communications into channels so that available frequency and common carrier (telephone) links can be employed. These channels have been mentioned before in a generally descriptive way and the following section provides the design foundations for system models and frequency planning. These are based upon:

1. A consistent treatment of radio and emergency request message traffic based on the population in each area,
2. A continuing utilization of much of the present system with augmentation through non-special new equipments,
3. A frequency plan based on required channel utilization and numbers of required links, the available frequency spectrum and necessary geographical separation to avoid interference,
4. Operational system performance characteristics based upon modern law enforcement communications standards meeting the requirements of this plan (Section 2.0).

4.1 FREQUENCY SPECTRUM USAGE AND CHANNEL PLAN DEVELOPMENT

Frequency channel planning is a very important part of any law enforcement communication system development. Previous sections have shown fundamental channel requirements for radio systems. Section 2.2.3 listed the channel requirements which are the guidelines for development and are approved by the LEATAC. Section 3.3.3 describes the required channel use in additional detail and provides an excellent background reference for the specific development of this section.

The primary radio channels required are: Operations, Information, Wide-Area, Tactical and Point-to-point. In larger systems, it is required that additional Operations and Information channel frequency links be provided because of the amount of population based message traffic in the area served. Additionally, there is often a need for special mobile-to-mobile aircraft-to-mobile and to base and portable-to-portable links for surveillance, radar, detective, and narcotic squads. Air-borne equipment is capable of transmitting over greater areas and is therefore restricted to portable unit power levels and frequency links normally used by mobile units.

The number of frequency links required for Operation and Information Channels is highly dependent upon the population of the specific area served by the system. The population of individual counties in Iowa varies from six thousand three hundred (6,300) persons to over two hundred fifty thousand (250,000) people. The frequency spectrum available for use in Iowa severely restricts the ability to design a frequency plan which meets all the channel and link requirements and utilizes only one band of frequencies designated for Police Radio Service by the FCC. All three frequency bands are required, that is low-band VHF, high-band VHF, and UHF. Much of the present radio communications in the state of Iowa utilize the low-band VHF. It is desirable to continue to operate much of the present low-band equipment and to designate the other frequency bands for communications activities which are not presently being satisfied.

Several items of planning criteria are considered in the development of statewide frequency plans to meet national standards and potential regional consolidation plan developments:

National planning for law enforcement communications is considered and includes interstate channel utilization and requirements for inter-state and inter-regional as well as inter-service communications.

Because there are insufficient frequency channels to provide clear channel assignments to each agency, it is necessary that each frequency used has a sufficient utilization in each assigned region.

The design must provide sufficient frequency links for each type of channel to assure that peak traffic loads in an area of usage do not form message traffic queues which exceed the maximum allowable channel wait time requirements.

The resulting plan must carefully avoid radio frequency interference and eliminate other types of interference produced by inter-modulation and co-frequency usage to gain a needed level of communications reliability.

The frequency plan and transmitter/receiver/antenna siting must enable reliable mobile-to-base and base-to-portable communications. The area of adequate signal reliability in portable-to-base operations may be considerably less than the area of mobile-to-base.

Based on these criteria, the frequency plans, equipment types and locations to fulfill various planning objectives and requirements are carefully developed in the following sections:

4.1.1 LINK REQUIREMENTS BASED ON MESSAGE TRAFFIC LOAD

Regional Grouping Selection:

The Operations Channel and Information Channel are nominally used for intra-agency communications and require a minimum interference in communications between the mobile and base units of a particular agency and within cooperating agencies. In some cases, frequency planning for these channels requires county groupings having a combined rural and city population which will provide for a sufficient message traffic load to justify the assigned frequencies. The criteria which are used in this report for the assignment of counties to the particular frequency planning regions are as follows:

1. Select a regional grouping of adjacent counties or an individual county which the combined rural and city populations are greater than 35,000 persons. This minimum population limit assures that the peak message traffic loading will justify Operations and Information Channels for that region.

2. Select the regional geographical boundaries to form an area so that it is cost effective to locate radio transmitting and receiving facilities in reliable base-to-mobile and mobile-to-base radio signal propagation will meet the required communications grade of service.

3. The regional and county grouping boundaries should be compatible with jurisdictional boundaries of the Iowa Council of Governments Office for Planning and Programming, emergency medical services, the Iowa Highway Patrol radio systems, and achieve non-interfering communications between these services.

4a. Develop a state-wide frequency assignment among the regions to assure an adequate separation distance between co-frequency regions so that cost-effective radio transmitting receiving system locations will not destructively interfere with each other when a frequency is used repeatedly in the state.

4b. Develop the frequency plan and corresponding systems design to provide sufficient Operations and Information Channel links which will assure that peak traffic will not overload the channels and cause a message traffic wait time to exceed the maximum allowable value.

4c. The frequency band used should allow for compatibility of inter-agency communications between the several agencies.

5. Frequency plans should provide for the use of present equipment to a maximum extent through frequency band selection and planning for use of low-band, high-band, and UHF.

6. Develop geograhical regions so that a cost effective transmitting and receiving system can operate within the entire region at a time when operational cost reduction demands further consolidation of facilities.

In Section 3.3.5 a predictive model for the state shows the expected message traffic based on the population census of 1970. Table 3-4 lists the predicted peak traffic loading per county for both emergency telephone requests and for radio messages. This is computed for both rural and city populations in those counties in which the city population exceeded 20,000. When the cities of a county have individual populations under 20,000, they are considered to fall into the rural communications message rate category.

This predictive model is utilized to collect groupings of counties meeting the population criteria. Figure 4-1 shows the resulting county groupings and lists the frequency plan. These county groupings satisfy the criteria and to favor regions which fall reasonably within or subdivide the jurisdictional boundaries of the Council of Government areas (Office for Planning and Programming, State of Iowa) shown on the map of Figure 4-2. Table 4-1 lists the counties of each region, population (rural and urban) and the peak busy hour channel utilization for radio and telephone (emergency requests). This table has a column indicating the population classes: the low population density category indicates those regions having in them essentially rural population and cities of 20,000 or less population. The high population density classifications refers to regions having one or more cities with population exceeding 20,000 persons. The population of these cities is shown in an urban category.

Development of Adequate Links for Channel Service:

Determination of the numbers of links required for each channel category in the selected regions utilizes an additional set of criteria based on channel response delay and the dispatcher action delay factors which have been established in the detailed requirements of Section 2 of this volume.

The development of this section assumes an average radio message length of twelve (12) seconds for the Operations and Information Channels and a twelve (12) second maximum wait time criteria. Wait time assumes that the dispatcher work load provides approximately an equal wait time for reaction response as the channel wait time for the channel to clear and further assumes that the response by the dispatcher should not be delayed more than twenty five (25) seconds at peak load occurrence. The twelve (12) second wait time allows utilization in a single channel not to exceed 45% (.45 Erlangs).

Radio traffic in areas having data services now is approximately one-third (33%) Information, and two thirds (67%) Operations traffic. The radio traffic predictions based on population are therefore assumed to be split by that ratio. Since separate links are required for the Operations and Information Channel activities, the traffic per each type of channel may be computed.

This implementation plan is based upon there being a Comm Center in each county which serves the cities and the rural population within each. There are several counties which have a population exceeding that required to justify a single Operations and single Information Channel link. These are indicated in Table 4-2 which also provided the listing of the required links for emergency telephone request lines. Table 4-3 shows the numbers of Operations and Information Channels required for expected ranges of traffic intensity. If a single communications center were developed for the regions shown in Table 4-1, the number of Operations Channel links required for this center could be computed using traffic intensity values in Section A of Table 4-3 and for the Informations Channel using Section B of the same table.

Telephone utilization figures in Table 4-2 were developed from the data of Figure 3-4 and specifies the number of emergency lines required to satisfy the channel utilization.

The volume of radio traffic for counties containing cities of over 20,000 population indicates the need for additional Operations Channels. High-band frequency availability limits assignments of more than one such channel in this band for city usage. Furthermore, the use of UHF for city communications is recommended by the FCC and offers adequate numbers of abailable frequencies for present assignments plus future growth. In those cities having a population above 20,000 but under 50,000, the number of UHF channels for operational utilization is one. That is, one additional UHF pair may be allocated to serve as an Operations Channel in addition to the County Operations Channel. For example, in Cerro Gordo County in Region 4, Mason City is able to utilize one UHF Operations Channel, but due to the total utilization at peak message traffic in Cerro Gordo County the single Information Channel on high-band should suffice for both city and county. Table 4-2 shows the total number of links allocated to that county within established criteria limits. These link assignments are independent of the collocation of county and city Comm Center. Where more than one Operations and Information Channel is listed, the extra channels are used in serving city systems. Where the message traffic utilization ranges exceed the values in Table 4-3, additional Information and Operation Channels are assigned in the UHF frequency band. Table 4-2 indicates the number of actual frequency links assigned to satisfy the response time criteria at peak traffic periods for both Operations and Information Channels.

Frequency Plan Criteria:

Certain criteria for the frequency plan development are established as follows:

1. The keystone to development of the Iowa Law Enforcement Communications System lies in the establishment of the Tactical Radio Frequency Channel. The frequency of 155.475 MHz which has been established nationally for this channel by recent action of the APCO in cooperation with the FCC. This link is operated in a simplex-single-frequency

mode without continuous tone code squelch and is to be used primarily by all agencies for mobile-to-mobile emergency communications. However base station operation by the county Comm Center is required for coordination of channel traffic,

2. The high-band Operations Channel is a simplex-single-frequency link required to carry the mobile-to-base/base-to-mobile traffic. Either the low-band or high-band may be used for county operations. In certain circumstances it may be desirable that both low and high-band links are used where radio message traffic exceeds 0.35 Erlangs. A state-wide Operations Channel low-band and high-band frequency plan is required to eliminate base-to-base destructive interference. Destructive interference is a signal level which can capture the receiver in another co-freqency region. CTCS will be available for mobile transmissions. The specific tone usage will be different in the nearest co-frequency regions so that co-frequency base stations and mobile units are not heard in another region. Additional city Operations Channels are assigned on UHF links in accordance with previous criteria and FCC regulations, Part 89.309. The UHF assignments assure that duplex pairs are available for each assigned link,

3. The high-band Information Channel can best perform its function in a two-frequency simplex mode. The mobile radio transmits on a mobile-only frequency which is, with few exceptions, a single state-wide frequency and utilizes CTCS encode. The CTCS tones used by the mobiles are assigned according to the planned list of Table 4-7. The base station transmitting frequency assignments are in accord with the regional frequency plan to eliminate destructive interference of transmissions received by mobile units in a co-frequency region. The high-band base transmitters do not transmit a CTCS tone. However, Comm Centers use a CTCS decode to receive the mobile channels. Each Comm Center must monitor their own transmission frequency. Additional operational practices are allowed:

   a. Mobile-to-mobile and aircraft-to-mobile unit communications may utilize the mobile-only high-band frequency if desired for message traffic and information transfer having a non-emergency nature.

b. A second mobile-only high-band frequency is assigned for high-band portable radio unit communications. The primary portable-to-base unit transmission frequency is always different than that of the mobile unit in a given county to avoid a power level conflict. This allows satellite receiver usage in remote areas of the county or city where portable communications may not be entirely reliable. Aircraft communications units can share the portable and mobile frequency for transmission. It is recommended that low power portable units are used in the aircraft. The air-borne units employ CTCS encode just as the ground mobile/portable operations.

Large city users utilize the UHF Information Channels, but may share the county-wide high-band channel,

4. The Wide-Area Channel utilizes the Iowa Highway Patrol Radio (IHPR) LEA frequencies. These frequencies were previously selected per a state-wide frequency plan and are being implemented in the IHPR system upgrade. Three (3) VHF high-band frequency pairs are available state-wide in a nine (9) region plan. The mobile units must employ a CTCS encode tone to activate the repeater,

5. The frequencies selected for the Information and Operations Channel are frequencies allocated in the FCC Rules and Regulations Part 89.309 for Police Radio Service, and do not produce destructive interference and are not interfered with by either in-state or out-of-state police services presently using them. Frequency coordination in adjoining states and within Iowa is required to assure this. This plan considers only frequencies which are available for coordination with minimum difficulty. Actual coordination activities may require certain modifications of the plan shown in this report. Additionally, high-band frequencies for each region are assigned in sets to assure, at least 350 kHz spacing between pairs in each region set of Operations and Information Channel frequencies. This separation allows simultaneous operation of these channels from a given site. The Information Channel frequencies are chosen reasonably close to the (Point-to-point) frequency (155.37 MHz) and the Tactical Channel frequency (155.475 MHz). It is not believed necessary nor is it technically practical to achieve simultaneous operation of these with the Information Channel, however, either one of the three may be operated simultaneously with the Operations Channel. (See 7 on following page). Frequencies selected

are removed more than 15 kHz from IHPR primary system frequencies and Emergency Medical Services frequencies, otherwise interference could be produced affecting those agency communications in areas close by the base stations and from operation of nearby mobile units. These criteria are fulfilled to meet FCC requirements for adjacent channel separation.

The overall end-to-end spread of frequencies assigned to both base and mobile Operations and Information Channels is within the 0.4% bandwidth of available radio equipment,

6. The low-band Operations Channel frequency plan is assigned in order to minimize the number of frequency modifications required for mobile units and base station equipments currently in use in the State of Iowa. In primary law enforcement communications it is desirable to avoid the use of frequencies designated by the FCC for Local Government. Therefore, 37.10 MHz is not utilized as an assigned frequency. The selected low-band frequencies are within a very small percentage of 37.10 MHz thereby allowing retuning of existing mobile and base equipments to the new frequency plan. NOTE: 37.10 MHz operation can be maintained in base stations and in mobile units for communications with public works, conservation, and other agency activities requiring inter-agency communications of law enforcement dispatchers and officers,

7. The high-band Operations Channel and Information Channel radio sub-system are designed in such a manner that they can operate simultaneously where both are employed at a given site location. That is, the Operations Channel transmitter when operating will not desensitize the Information, Tactical, or Point-to-Point receivers. Vice versa, when either the Information, Tactical Point-to-Point channel transmitter operates, the Operations Channel receiver sensitivity will not be reduced,

8. In the high-band VHF and UHF frequency plan design there are various forms of intermodulation possibilities which are considered. The IM products of these frequencies are either eliminated or minimized in the plan. The forms of IM which are analyzed are:

a. Transmitter final stage
b. Receiver mutlicoupler
c. Products generated within a receiver when one or more strong signal frequencies are received simultaneously and mix with high order harmonics of the receiver local oscillator.

4.1.2 FREQUENCY PLAN ASSIGNMENTS

The frequency plan is developed on the basis of the criteria of this and the previous section. The plan was discussed in depth with the Chairman and several members of the Iowa APCO Frequency Coordination Committee during the period of development. All possible precautions are taken to minimize problems in final coordination and eventual FCC licensing of individual agencies as this plan is applied. Even so, some local changes may be required when final license applications are requested. These changes should be made within the bounds of planning criteria and analysis of this plan.

Consideration is given to all the objectives of the previous section. Regional assignments are made to reduce signal interference from outside the state and also within the state for the adjacent 15 kHz frequency licensees. Intermodulation (IM) products are computed for combinations of frequencies selected. Equipment design recommendations are made to reduce potential IM effects to adjacent services where there is no other way to eliminate potential reradiated signals. Of course, it is beyond the scope of this phase of effort to consider all possible sources of IM signals generated in the vicinity of the base stations. However, the generated components from within the system and from other known state-wide systems of public safety are analyzed. Tables of specific analyses are presented which substantiate the specific frequency plans.

LOW-BAND PLAN

The six (6) frequency low-band set is assigned to frequency plan regions as shown in Table 4-4. This figure also shows other states usage. The geographical distribution may be visualized from the state/regional map of Figure 4-1. Both the low-band and high-band plans fit identical regional boundaries.

TABLE 4-4 LOW-BAND FREQUENCY PLAN

Set No.	Frequency - MHz	Regional Assignments	Out-of-State Usage
L1	37.08	8, 11, 18, 22, 24	New Jersey
L2	37.12	1, 10, 17, 19, 23, 31	Florida
L3	37.14	2, 14, 16, 27, 30	None Known
L4	37.16	4, 6, 21, 26	Arkansas
L5	37.20	7, 9, 12, 20, 29	Arkansas
L6	37.24	3, 5, 13, 15, 25, 28, 32	Arkansas

The total frequency spread is 0.43% and is 0.38% from 37.10 to 37.24 MHz. This essentially meets the practical receiver and transmitter mobile equipment bandwidth limitation.

This plan maintains a best possible status quo of present frequency usage in each region as determined by weighing the number of mobile units now using the frequency in the counties and cities to those which are changed per regional plan. The plan shows a strong relationship to the APCO State Communications Committee frequency plan of 1969 (Reference 19) which if fully implemented, would have reduced greatly the co-frequency interference in the low-band operations.

Interference - Low-Band:

Interference probabilities in each county are analyzed and presented in Table 4-5. The interference shown includes both that due to base-to-base/mobile-to-base of co-frequency regions and the self-interference provided by the counties of a given frequency regions as weighed by their peak channel utilization factors. The resulting maximum interference meets a criterion of not to exceed a 5% (.05) service probability index reduction from the service probability index computed without interference. The Interference Reduction Factor (IRF) must therefore be greater than 0.95, for it multiplies the SPI computed without interference to provide the SPI resulting when maximum interference is present. Reduction factors shown in Table 4-5 indicate the high reliability available when the frequency plan is implemented.

Operational Note:

Usage of identical frequencies in all the counties of a given region makes necessary that each radio operator listen to the transmitted channel frequencies before transmitting. This is a standard operating procedure required by the FCC. Should a single Comm Center be developed for a region there will be no operational conflict except between operators within the Comm Center trying to key the same transmitter from separate consoles. Skip interference will occur because on ionospheric and occasional sporadic E support phenomana. The selected frequencies have minimal usage and the support probabilities are relatively low for Arkansas, i.e. 1% versus 6% for Florida and New Jersey at the summer noontime with sunspot number equal SSN100. See out of state usage, Table 4-4.

HIGH-BAND PLAN

The Operation and Information Channels require several frequencies for each channel. A six (6) frequency set is provided for each channel and the selected frequencies are listed in Table 4-6 and are shown geographically in Figure 4-1.

Many of the high-band Police Service frequencies listed in the FCC Rules and Regulations Part 89.309 are used in adjoining states and therefore are not available. Other frequencies are not available because they are within 15 kHz of the IHPR or EMS frequency plan sets. To accomodate a difficulty in assignment, a minor regional change was requested of the EMS frequency plan coordinator.

TABLE 4-6 HIGH-BAND FREQUENCY PLAN

Set No.	Base/ Mobile Rx Operations	Base Tx Information	Information-Operational Channel Difference Frequency, MHz	Regional Set Assignments
H1	154.725	155.250	.525	7, 9, 20, 24
H2	154.830	155.310	.480	2, 12, 15, 18, 25, 28
H3	154.845	155.520	.675	8, 11, 17, 19, 23
H4	155.010	155.535	.525	3, 5, 14, 27, 29
H5	155.070	155.580	.510	6, 10, 21, 26, 30
H6	155.190	155.610	.420	1, 4, 13, 16, 22, 31, 32
	155.910*	Mobile Transmit (State-wide)		
	155.850	Portable Transmit (State-wide)		

* In certain regions there is an interference of out-of-state base and control stations making necessary substitution of another "mobile only" frequency. The mobile only 155.970 and 156.030 MHz frequencies are specified in these regions as shown in Table 4-7. These frequencies may be used in other regions for mobile-to-mobile special functions such as detective, radar, narcotics and surveillance, and may be used for aircraft as well.

Interference - High-Band

The Operation Channel functions in a single-frequency simplex mode, which allows both base-to-base and mobile-to-base co-frequency user interference. Of course, the base-to-base transmission produces the predominate interference in co-frequency base receivers.

The Information Channel functions in a two-frequency simplex mode, which allows only mobile-to-base and base-to-mobile interference to occur between co-frequency users.

Table 4-8 shows the results of the Operations Channel high-band base-to-base interference reduction analysis for each county. This is the worst case which would occur in Operations Channel usage when base-to-base interference predominates. Interference is quite low region-to-region and is well within the objective limit of 5% SPI reduction.

The majority of remaining interference occurs from multiple Comm Center and base station operations within a frequency region. As in the low-band plan, the peak traffic loading was used to compute interference reduction factors and even so there is only a small reliability reduction. The mobile-to-base interference is substantially less than the base-to-base and rules out significant co-frequency regional usage in the Information Channel.

CTCS decode used in the base receivers will eliminate base-to-base and mobile-to-base residual nuisance interference fom the Information and Operations Channels from co-frequency regions which could occasionally occur if CTCS were not used.

The Comm Center radio dispatcher will monitor, as standard practice, the Information Channel base transmit frequency to determine the intra-region usage before the transmitter is keyed.

<u>Transmitter - Final Intermodulation - High-Band</u>

Intermodulation product possibilities are analyzed for each of the frequency sets employed. The selected combinations eliminate almost all potential problems. The high-band products are shown in Table 4-9. This table lists all third-order intermodulation signals produced in the transmitter final stages for the Operations , Information, Tactical, and Point-to-point Channels.

The first four (4) frequencies, listed in Table 4-9 are transmitted and may cause final stage IM. Not all are operated simultaneously, for only the Operations Channel transmitter and <u>one</u> of the other three can be keyed simultaneously. The columns provide the IM frequency generated when simultaneous transmissions occur on those combinations. For example, the third-order product of 154.20 MHz is produced in set H1 when the Operations Channel (154.725 MHz) is transmitted simultaneously with the Information Channel (155.250 MHz). Other combinations may be found in an identical manner.

Transmitter third-order IM products are reradiated at a level approximately 12 dB (plus antenna gain) below the least signal-component-level appearing in the final transmitter stage producing the distortion. These reradiated products may cause receiver degradation at distances of five to six miles when the IM frequency occurs within a receiver acceptance bandwidth (up to 15 kHz). The fifth-order IM products produced are approximately 35 dB and the seventh are 45 dB below signal component levels. The latter products are sufficiently low that reradiated signals are not expected to cause serious degradation of other systems unless their antennas are collocated or within a few hundred feet. IM frequencies products (Table 4-9) fall largely within the Fire Service frequency group and the State Fire Mutual Aid frequency is the most often affected. Only a few others cause potential interference. Table 4-10A shows the location (region/city) and frequency for those agencies having potential problems. The specific nature of inteference must be determined by qualified technical personnel in each of these areas as the system is installed.

Should it occur, the problem can be readily solved by insertion of a notch filter or isolator in the transmission line of the offending transmitter.

Multicoupler Intermodulation:

Intermodulation products are formed within the receiver multicoupler when two or more strong (> -20 dBm) signal frequencies are received simultaneously from another base station or from mobile units transmitting within a mile or so of the receiver, multicoupler and antenna. The system plan provides a multicoupler for the simultaneous connection of Information, Tactical, Point-to-point and Portable Channel receivers. The latter four frequencies in each set of Table 4-9 lists the multicoupler third-order intermodulation product frequencies. There are no IM frequencies equal to a desired signal frequency or within the acceptance bandwidth of a receiver. In sets H-5 and H-6 the apparent production of 155.37 MHz signal energy shown under column ($2f_2$-f) is not truly produced since the mobile units do not transmit on the base Information Channel frequency and furthermore when the base Information, Tactical, Point-to-Point Channel transmitter is keyed the corresponding receivers are muted; thus, will not be able to receive the IM audio product if the rf product were produced.

Table 4-10B lists additional IM intermod products (third, fifth and seventh order) either within the transmitter or multicoupler by any combination of two known law enforcement, fire, IHPR and EMS frequencies. This table should be valuable for use during the implementation of the system when considering either the collocation or proximity of two signal sources. These are reduced from compilation of known public safety signal product combinations of third through seventh order.

Receiver Intermod Analysis (High-Band)

Receiver spurious and intermodulation products are analyzed for typical receiving equipments, e.g. the GE Master II and the Motorola MICOR receivers used in base and mobile equipments for all input frequencies that at present are known to be present in the region of interest. The analysis does not attempt to calculate the degradation of performance; principally, because the specific levels are not known. Therefore, only the existance of possible spurious or intermodulation products is defined. Table 4-10C lists the receiver signal frequency that would produce a spurious response when tuned to the received frequency listed. Responses are produced by the receiver local oscillator nineteenth harmonic in the case of the GE receivers and the twentieth harmonic in the case of the Motorola receivers. Local oscillator harmonics mix with the second signal frequency harmonic to produce the IM. These high order products have little possibilities of producing degradation of receiver performance, however, on occasion trouble may be found. Reference should be made to the Table 4-10C for assistance in locating trouble produced by a strong signal.

UHF FREQUENCY PLAN

UHF frequency planning is applicable to city system usage. Table 4-11 lists the transmitter frequencies assigned to cities which meet the UHF utilization criteria. This table also lists frequencies now licensed or known to be involved in coordination processing. It also included frequencies used in Omaha where seven (7) frequency pairs are utilized.

The frequency plan functions generally in a two-frequency duplex operation, in which a pair of 5 MHz spaced frequencies are assigned. The frequency near 465 MHz is the base receive frequency and 460 MHz is the base transmit frequency. Mobile transmit/receive frequencies are oppositely used. The frequency assignments shown in Table 4-11 provide the required link pairs to satisfy present and projected needs.

Base stations are designed to operate in two modes:

(1) Repeater operations, wherein operation is full duplex to allow mobile transmission relay between other mobile units within the design radius for signal coverage. Comm Center radio operators can monitor the repeater audio ouptut. CTCS encode and decode is used in both base and mobile equipments.

(2) Standard base station, two-frequency simplex operation under control of the Comm Center radio operator. This mode is used for mobile-to-base and base-to-mobile radio communication services. This mode, too, employs CTCS encode and decode both at base station and mobile units.

Satellite receivers are employed when required for assuring adequate signal reliability for portable operations especially in the portable-to-base link.

Mobile-to-mobile communications when operating without a repeater function are accomodated through usage in the mobile of the base transmit frequency (460.XXX MHz) in a simplex single-frequency mode by equipping the mobile unit with a receive channel on the transmit frequency. CTCS may or may not be used, optionally, dependent upon local operating procedures. This operation requires a monitor receiver at the primary base station for the channel frequency used. This frequency should be a channel which is seldom used for Operations or Information Channel functions.

Small cities can justify a single frequency pair to serve the UHF Operations Channel function, wheras large cities require more than one Operation and Information Channel.

The CTCS tones are assigned to provide co-frequency nuisance interference protection. Also a capability is provided for adjacent jurisdictions to utilize a common frequency for mutual aid and inter-agency coordinations. It is believed this has outweighing advantages, although there is a possibility for intermodulation product reception produced within the agency employing a number of transmitters. The CTCS can be disabled, for use in mobile-to-mobile or for portable operations when the repeater or satellite receiver be turned on.

The frequency plan is designed to avoid co-frequency interference and intermodulation problems, although whenever several frequency pairs are assigned to larger cities there is a strong possibility for intermodulation product formation in adjacent transmitters. For example, analysis of the intermodulation products (IM) for frequencies now assigned in Des Moines proved that third order IM is now possible between the 460.325 MHz and the 460.150 MHz frequency. Therefore, it is recommended that Des Moines change from the 460.325 MHz frequency to 460.350 MHz to eliminate this product.

The third order IM products for each of the cities utilizing two or more channels are shown in Table 4-12. Fifth and seventh order products generally will be reradiated at a 20 dB and 35 dB lower level than the third order which will render them insignificant.

A potential intermodulation problem can exist for West Des Moines and Des Moines, as shown in the following example. The third order product formed by mixing of 460.150 and 460.225 MHz is 460.075 MHz. This is a receive frequency for the West Des Moines mobile units. If the CTCS frequency were different, only a "sometimes" desensitization would occur. However, the CTCS identity will potentially open the mobile unit audio in West Des Moines. The required solution is to insert an isolator in the 460.150 MHz Des Moines transmitter output transmission line if this becomes a problem.

Worst case level computations show the following:

+20 dBw	460.225 Tx output (100 watts)
+18 dB	Antenna Gain both transmitting sites
-80 dB	Freespace attenuation between transmitting sites (Least value estimated).
-12 dB	Conversion gain of IM product in 460.150 Tx final
+ 9 dB	Antenna gain to radiated IM product (460.075)
	NOTE: If an isolator is used, a factor of 25 dB loss could be expected for reradiated IM component.

-100 dB	Free path loss (6 miles) between the Des Moines base and a West Des Moines mobile unit (Least loss expected)
+ 3 dB	Highest moible antenna gain expected.
-142 dBw	Received signal level at mobile unit.

NOTE: (1) The receiver is quieted 14 dB SINAD at a received power level of -142 dBw, so this IM level will densitize the receiver in excess of 3 dB.

(2) The isolator insertion will reduce the radiated IM in excess of 25 dB. Thus, the problem is eliminated.

4.1.3 CONTINUOUS TONE CODE SQUELCH SYSTEM PLAN

Continuous Tone Code Squelch (CTCS) is utilized to encode a unique subaudible tone modulation onto a transmitting unit output signal, which when received and decoded will switch "on" the audio output of the receiver. Adequate frequency planning as employed in this design plan eliminates destructive radio frequency interference, however under certain conditions distant stations can cause nuisance interference when received in the base stations and to a lesser degree in the mobile units. This interference is eliminated through use of the CTCS.

CTCS frequency plans developed state-wide in this system implementation plan provide a uniquely different tone code in the mearest co-frequency regions or cities (using UHF band). It is unnecessary to have all codes unique. Four (4) separate CTCS frequencies, Table 4-13A, are utilized from the EIA RS-220 group B sets. The tone frequencies used are the same as those employed in the Iowa Highway Patrol Radio (IHPR) CTCS because of the Wide Area Channel which will utilize the IHPR local law (LEA) channel repeaters. (See table 4-13B). The assigned county usage of the CTCS tones is shown in Table 4-7 and for city assignments (UHF) in Table 4-11. Certain other tones are used in city systems determined by present usage. Both encode and decode is used in the Mobile/Portable and base station UHF equipment except when mobile-to-mobile communications is employed.

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1 OF 4

The mobile radio unit transmitter in each specific frequency region is equipped to modulate sub-audible tones when transmitting on the Operations Channel (low or high-band), the Information and Wide Area Channels. The CTCS is not used in the Tactical Channel, for the rf squelch opens this channel to each user regardless of area assignment. Decoding will be performed in the base receivers for those channels using CTCS. A retrofit field modification is specified for the high-band mobile radio to add a tone decoder should the high-band system operational usage require it at some future data in certain areas. The geographical separation of co-frequency/tone regions is sufficient that in single-frequency simplex circuit operation no units should interfere with each other. Two-frequency simplex operations are less susceptable.

The wide-area Channel requires a separate CTCS tone plan due to the different geographical areas of the IHPR than used in the state local law frequency regions. The IHPR utilizes multiple radiating sites (repeaters) in a given radio district for both privacy and Wide Area Channel operations. For example, the Storm Lake IHPR region has a base site and three remote base/repeater site operations. To avoid enabling more than one repeater, the Highway Patrol mobile radios are equipped with selectable tone codes so that, dependent upon their location, they can actuate a specific base or repeater. Table 4-13B shows the CTCS frequencies used. The Wide Area repeater channel operation is such that several counties have within them equal signal propagation reliability from two repeaters. In large counties this situation requires use of two CTCS codes in order to actuate the specific repeater which will most reliably repeat communications between two mobile units. Therefore, it is found desirable in fifteen (15) counties, to utilize a two position tone-code frequency select switch. This is evident in the Table 4-7 where, for example, Region 19 (Audubon County) employs two CTCS frequencies for actuating either the Denison or Guthrie Center Wide Area repeater.

In the Operations Channels (low-band or high-band) and in the Information Channel mobile radio must be ordered so that the channel select switch will also activate the tone-code frequency for a given county.

The Tactical Channel switch position also is wired to produce no CTCS frequency encode at the mobile transmitter. The Wide Area Channel is wired in the mobile such that the CTCS frequency is selected from the single or pair of frequencies which are available in the county. Each mobile unit tone generator is capable of producing any of the four tones. A field modification is required to change the wiring of a unit so that it could be transferred from one to another operational area.

4.1.4 POINT-TO-POINT CHANNEL

The Point-to-Point Channel usage is changing and further change is expected. A nationwide channel usage such as this cannot be changed by or within any one state without regard to the implications of various interstate traffic handling procedures and usage within the state as well. The communications requirements of this plan in the State of Iowa recognizes the need to utilize the Point-to-Point Channel as an emergency stand-by link to landline communications. This is true of voice transmissions and additionally, could be true of data transmission applications. Data circuits back-up is particularly important because at present, there is no alternate link should common carrier services fail. It is recommended, therefore, that methods be developed to allow the Point-to-Point Channel radio system equipment to operate a simplex voice-grade-link to receive transmit data from another agency within radio range. It is recognized that most common carrier data systems are four-wire full-duplex systems for fully automatic operation. A duplex frequency pair would be required to obtain this mode via Point-to-Point. As an emergency stand-by mode, this is not considered necessary.

The Point-to-Point radio channel presently has much base-to-base interference associated with it. Therefore, many radio operators turn the squelch tight or mute the audio output to the speaker and hence it is often not possible for agency dispatch centers operating in this manner to receive a call from another center. One of the possible ways to overcome this deficiency would involve developing a nationwide selective calling and CTCS. Presuming the nationwide system used standardized calling codes assigned through state or regional planning, it would then be possible to employ the Point-to-Point Channel in a way quite similar to that of telephone circuits between adjacent centers. Due regard to destructive interference of other centers will have to be considered with use made of directional antennas.

It is recommended that the Director of Communications of Iowa and the Chief Radio Engineer engage in interstate discussions with other states communications personnel who are responsible for planning; with the FCC, and with the APCO, in an attempt to convert the 155.37 MHz frequency usage from a single frequency simplex, non-CTCS and non-selective calling, to a system which has CTCS/selective-calling with nationwide standards for code assignment and procedural use and to request reassignment as a "base only" frequency.

When this is accomplished, the 155.370 MHz channel can become a back-up channel with sufficient utility to justify its use in emergency and disaster situations. If this does not occur, the FCC may well omit its use and relegate it to radio base-mobile/mobile-base channel usage instead. In this study the design criterion makes necessary a county-to-county communications Obviously, much more range is possible with base-to-base communication. Upon accomplishment of further planning, criteria for beamed transmissions or for limiting the omnidirectional range of transmissions will doubtlessly require a thorough analysis of these system parameters.

IAWAS - Severe Weather Warnings

The Point-to-Point Channel is presently used throughout Iowa by the Iowa Highway Patrol Radio Centers to broadcast an alert to all county centers of an impending severe weather disturbance. These broadcasts are additionally monitored in many hospitals, schools and industrial safety offices. It is recommended that this usage continue. A further recommendation is that the severe weather "Watch" be distributed to the patrol units via the Operations Channel and where an area severe weather "Warning" is issued, the Tactical Channel be used by the county Comm Center to broadcast to patrol units in that area only (subject to approval of the Tactical Channel Rules and Procedures Committee).

4.2 SYSTEM DESIGN PARAMETERS AND CRITERIA

This section provides the objective parameters upon which the system design is developed. Tables containing design data have been previously referenced. Many of these tables were developed with reference to these parameters and criteria.

These criteria and their application are based upon fundamental and well-known engineering and statistical principles. They are used to satisfy the delay time and response requirements for overall system operations. Specific agency requirements may shift slightly the operating parameters from those shown to achieve the most economical and satisfactory performance in a specific system.

4.2.1 COMM CENTER DESIGN PARAMETERS

Dispatcher position numbers recommended are shown in Table 4-2. The column numbers are based upon the generic population of city-county joint operations. A utilization factor is used to determine dispatch position numbers. Both the radio and telephone (emergency) utilization factors are summed in Table 4-2 to determine total operator utilization. The assignment of peak utilization for each operator from the combined radio and telephone activity should not exceed approximately 25% because outgoing line, data system and record logging activities add to operator work loads. As the number of operator positions increases, a greater handoff ability occurs between operators, so the utilization per operator can increase according to the following approximate values of utilization factors:

Total Utilization	No. of Radio Operator Positions	
.25	1	
.25 to 1.00	2	
1.00 to 3.5	3 Note:	A separate telephone operator position is required when the total utilization exceeds approximately 2.5
3.5 to 7	4 Note:	Two telephone operator positions are required when the total utilization exceeds 5.5
7	Requires a specific organization arrangement to determine the operator assignments.	

While estimates have been made for the number of dispatcher positions, after total utilization exceeds a factor of 7; there should be a more definitive work station study performed within the department to determine task assignments and operating positions in terms of actual traffic and district operations.

The number of operators required to service the incoming emergency telephone lines is based on the following tabulation of operators required per line grouping.

LINES	OPERATORS
2	1
3 to 5	2
6 to 8	3
9 to 11	4
12 to 15	5
15 to 19	6

Radio operators also answer telephone emergency lines in small Comm Center operations. As the activity and total utilization factor increases, more specialized operations are assumed as noted in the above Radio Operator Position tabulation. Larger centers show as listed in Table 4-2, an extra radio operations console above the number of operators. This makes it possible for the shift supervisor to operate that console under peak load conditions.

The peak-shift staff is that required to operate all work stations. The communications supervisor is assumed to operate one work station at the peak busy hour. The total dispatch staff required for a 24 hour/7 day, year-around operation is fifty percent (50%) more than the daily staff. This accounts for vacation, sickness and week-end shift activities.

The geographical location of the Comm Center physical facilities is not critical, however, it is desirable to co-locate the Comm Center at the site of the base station to eliminate the need for using the local telephone exchange to provide remote control of the base station. The lack of co-location of the Comm Center and base station is a small price to pay for the convenience and administrative control advantages of placing the Comm Center in existing facilities. Further convenience is achieved when the Comm Center is in the close proximity of the cooperating agencies, particularly when the base station site is located in an area of poor personnel accessibility.

The floor space required for the physical facility (building) in which the Comm Center is to be located is a function of the number of operator positions required to support the local communications system. The small Comm Center may be easily accommodated in a 10' x 12' room, including the control console and Teletype terminal. The larger, more complex Comm Center may involve the use of one large room, or more than one room. The following areas need to be planned, in addition to the dispatcher positions and supervisor area:

1) File and record space.
2) Emergency power
3) Restroom facilities
4) An administrative office(s)
5) Visitor entry area (optional)

Once the Comm Center location has been determined, it is next necessary to adapt the building to meet requirements. Three primary considerations desirable for the room(s) used for the Comm Center include:

1) An elevated floor for the purposes of allowing systems interconnection, wiring, and the ability to expand the system. Such a floor is typically raised six (6) inches above the sub-floor.
2) Emergency power will be required, not only for purposes of maintaining reliable dispatch communication and lighting, but also to continue air conditioning, ventilation, and other ancillary operations.
3) The ability to achieve physical security is necessary such that the vital activities of the Comm Center may be made invulnerable to physical attack and also to afford privacy.

There are several general design parameters which should be recognized in the design implementation of the Comm Center:

1) The floor requirement per operator is affected by many factors such as facility lay out, room shape, console(s) design and size of equipment. For initial planning purposes it is recommended that 125 square feet of area per operating person be allocated to the Comm Center.

2) The lighting level at the console should be adequate to facilitate easy reading of all controls without eye strain, and should normally be in the range of fifty (50) to one hundred (100) foot-candles, measured at the control panel surface. All consoles should have glare-free surfaces to reduce operator eye fatigue. Individually adjustable console lighting levels should be installed at both the radio dispatcher's console and the telephone dispatcher's console positions. When there is an additional Teletype room and Communications Center Director's office, the lighting levels of these should be in accordance with normal office lighting standards. Area maps, bulletin boards, and scheduling boards may require special lighting treatment.

3) Proper acoustic design must be achieved, for one of the primary functions of the Comm Center is to achieve distinct intelligibility of verbal messages received from the communications equipment. In order to achieve acceptable intelligibility, the acoustical design should provide acoustic planning including the use of sound-absorbing materials, barriers and proper distances between consoles to minimize the sound level at each dispatcher and operator location. It is recommended that the sound level resulting from all acoustic interference from adjoining areas does not exceed 70 dB (flat noise) at the hearing position. Each operating console should provide an acoustic noise level not to exceed 75 dB at the operators hearing position. In general, the Comm Center room acoustical power level should be approximately 65 dB or less with all consoles and peripheral equipment quiet. The use of acoustic absorbing materials in the ceiling, walls, and floor is advised to eliminate and reduce sound

reflections emanating from noisy items such as Teletype machines or from voices.

4) Sufficient conduits should be provided in appropriate locations in order to handle all wiring of power and communications, control trunk and circuits needed in the operation of the Comm Center and its interface with the equipment and communications links outside of the Comm Center.

5) It is desirable to limit access to the Comm Center. Comm Centers and telephone complaint reception desks are frequently accessible to the general public. These vital functions should be made invulnerable to physical attack and they should afford privacy. Measures used to safeguard the Comm Center may include electronic sensing devices, armed guards, specially designed door locks, and concealed location(s). Door should be equipped with automatic closers to insure against their being inadvertently left open. Such measures are considered necessary because disruption of the Comm Center can result in the paralysis of law enforcement within the entire geographical and administrative boundary of the communications system.

6) The building and emergency electrical power capabilities must be adequate to handle the power requirements, both present and future, to support the Comm Center. The power requirements may be easily established by a listing of all power consuming equipment and the summing of the maximum power drawn by each. Be sure to include an allowance for optional items, such as convenience outlets which may service displays, time stamps, coffee pots, electrical heaters, and other items.

Lighted map displays which combine with status recorders show dispatchers the location of their in-service officers. This is particularly significant where the traffic activity requires two or more dispatch personnel, i.e. when the total utilization factor exceeds one (1%).

Presently available lighted map displays were largely found to be out of service because of unreliable switches and incorrect lighting arrangements.

While improvements may have been made in available displays, it is recommended that only limited installations of these be authorized and a study made of their operation to ascertain their value and reliability. The Division of Communications and LEATAC or their contract agents should determine the objective value and reliability before further authorization for these units is made. Comparison of these displays with computerized status and information systems will be valuable in determining the cost effective trade-off between these systems.

4.2.2 SIGNAL RELIABILITY

In the design of an operational system it is necessary to provide specifications for several communication parameters which determine the signal coverage reliability base-to-mobile and mobile-to-base within a county or a larger region made up of several counties. This set of parameters is somewhat dependent upon a frequency plan which will eliminate interference producing a reduction of signal coverage (SPI) when channel message traffic is at peak value. Site location, the placement of the tower, antennas and transmission line characteristics are included in the list of system design input parameters.

The following criteria insure in land mobile public safety radio service system design that an adequate, but not excessively high, performance index exists over the area of interest. As described previously*, the performance index is characterized in relationship to message reliability through the term service probability index (SPI). The Longley-Rice method is employed with the service probability index concept to statistically incorporate the effect of time and spatial variations in the land mobile services. The service probability index (SPI) is simply the confidence level that the specified grade of service will be met in operations. Satisfactory service exists if the required signal-to-noise ratio is exceeded for at least a fraction Q_t period of time (time availability) and at a fraction Q_l of all possible locations (location variability). The following

* The Spectra Radio Communications Prediction Program and Reference 7.

system design criteria are based on experience that has been gained with the applications of this method:

A. Design Criteria

1.	(a)	Low-band, high-band, Rural areas, traveled routes	Time Availability: 95% Location Variability: 70%
		Mobile-to-base and Base-to-mobile	Marginal Coverage Area (under 50% SPI) shall be less than 1% in any communication service area.
		Median required S/N_0	50dB
	(b)	High-band, base-to-Portable	Same as for 1(a) except 5% marginal coverage area is acceptable.
	(c)	High-band, Portable-to-base	Same as for 1(a) except full area coverage is not required. Utility is largely portable-to-mobile or portable-to-portable.
2.		UHF Band Municipal areas	Time Availability: 95% Location Variability: 90%
		Portable-to-base/ Base-to-portable (Performance in the mobile mount is improved over portable-to-base)	Required Service Probability Index Downtown areas and business districts (SPI) 90% Suburban Areas, Airports (SPI) 70%
		Median required S/N_0	50dB

The SPI at municipal corporate limits should be in the range of 70 - 90%. with the conditions specified above.

B. Co-Channel Interference

1. Base-to-base interference, single frequency simplex, Operations Channel is worst case.
2. The SPI at regional boundaries shall be held to a minimum consistent with the design criteria of"A".
3. The combined interference reduction of the primary service probability index from a given base or repeater site caused by all external co-channel locations shall not exceed 5% when these sources are properly weighed by their predicted peak busy hour message traffic.

C. System Noise and Signal-to-Noise Performance

In any radio communications system design, one of the most important aspects is in the assessment of the external noise fields (man-made, signal power, other co-frequency signals, atmospheric, galactic, etc.) and the comparison of these with internal noise levels of the receiving system. Any receiver internally, injects more noise into the system than that due to the thermal noise power of its input resistance. The relative amount of additional noise power injected is called the receiver noise figure. A receiver injecting no additional noise has a 0 dB noise figure. Most low and high-band fm receivers possess noise figures in the range of 3.5 to 12 dB. There is a quantitative relationship between the receiver noise figure and the receiver sensitivity for 20 dB quieting. This is illustrated in Figure 4-3. (An equivalent curve may be drawn for the 12 dB SINAD case.) In an fm system, the rf squelch is usually set to operate at a signal level just above the combined external and internal receiver noise power. This threshold operational squelch level should provide quieting of just under 20 dB. This allows usage of the maximum specified sensitivity of the system. Of course, if the external noise is greater than internal receiving system noise, the receiver effective sensitivity is reduced.

When the noise figure of a receiver is known, it is a simple matter to convert this to the equivalent noise power at the receiver input terminals; thus a receiver with a 6 dB noise figure has an equivalent input noise power per Hz bandwidth of -204 dBw (Thermal noise/Hz).

$$\begin{array}{r} +\ 6 \\ \hline -198\ \text{dBw} \end{array}$$

Transmission line filter and connector losses add directly to the noise figure of a receiving system. Nominal values for system equipment specifications were used for assignment of reliability analysis.

The available noise power from external noise fields can also be expressed in dBw as follows for the three (3) noise grades used in this study and for high and low-band frequencies:

Available External Noise Power dBw/Hz

Noise Grade	Low-Band	High-Band	UHF
1	- 158.4	- 171.1	- 181.1
2	- 171.2	- 183.3	- 194.7
3	- 184.2	- 197.2	- 204.0

Subtracting these values from -204 dBw yields the equivalent external noise figure. A receiving system has minimum acceptable noise performance if the receiving system noise figure (receiver nf + transmission line loss) is less than the equivalent external noise figure by at least 6 dB.

With these considerations, the basic receiver noise figure specifications for base station equipment and mobile units have been determined. The noise grade is assumed to be approximately Grade 3 for rural areas and as low as 1 for highly urban areas.

The use of a state-of-the-art receiver multicoupler relieves the problem of selecting a base station receiver required sensitivity and intermod specifications. For example, a low noise multicoupler with sufficient gain can improve the receiving sensitivity of a receiver from 0.5 to 0.35 uv for 20 dB quieting. Therefore, in the specifications which have been drawn, receiver and multi-coupler performance characteristics have been combined to produce the proper system sensitivities and intermod performance.

Additional comments on specified mobile receiver sensitivities are in order. In certain densely populated regions, mobile receivers need not be particularly low noise because of the high external noise and thus, the intermod performance is far more important.

D. Design Parameters Used for System Analysis

For purposes of service probability index determination, the following basic system design parameters were employed:

Base Station Transmit Power

Low-Band	100 watts nominal
High-Band	100 watts nominal

These levels are keyed to mobile performance to assure a reciprocal mobile-to-base and base-to-mobile reliability.

<u>Mobile Unit Transmit Power</u>

Low-Band	100 watts nominal
High-Band	100 watts nominal

This level is chosen to achieve adequate performance to the IHPR Wide-Area repeater on high-band and on low-band to match present usage and to obtain reliable mobile-to-mobile performance.

<u>Portable Unit Transmit Power</u>

High-Band	1 watt
UHF	1 watt

Nominal transmission line losses were assumed in the base stations assuming that 7/8 inch heliax is used when lengths exceed 100 feet.

<u>Receiver Sensitivities (Noise Figure)</u>

Low-Band base station	10 dB
High-Band base station	10 dB
Low-Band mobile	10 dB
High-Band mobile	10 dB
High-Band portable	10 dB
UHF base station	10 dB
UHF portable	15 dB

<u>Antenna Characteristics</u>

Base Station (Low and High-Band)	As required per county, see Table 2-4 Volume I
Mobile Unit (Low and High-Band)	0 dBi omni gain
High-Band Portable	Omni gain with an efficiency of -12 dB
UHF Portable	Omni gain with an efficiency of -8 dB

This is the worst case for UHF because the mobile mount for the portable unit provides an overall antenna gain of approximately 0 dBi.

4.2.3 THE RATIONALE OF COUNTY SITE RE-LOCATION

In each of the ninety-nine (99) counties, the process of updating the existing base site was considered in detail. This entailed a careful examination of the topography, the signal reliability, and a cost trade-off of analysis of locations. A decision was made in each case on the cost of increased tower heights at present locations versus a shorter tower at the ideal location. The process employed to aid in this decision was as follows:

(1) Topographic maps of the Iowa counties were studied and the average height of the best 10% prominences determined within a radius of about seven (7) miles from the present site.

(2) This value was compared with the MSL of the present site and the difference used as an offset to add to the nominal tower height required to achieve reliable signal coverage of the county area. Required nominal heights were determined from computer signal reliability tabular listings.

(3) Ideal location tower heights to achieve required SPI were determined from computer listings.

(4) Based on the difference in tower heights and the distance to the remote base, a cost comparison analysis was performed and the final site preference determined. This included the costs of guyed versus self-supporting towers.

After the completion of this analysis, it was found that there was a definite preference for relocation of ten (10) county base sites, i.e.:

Ida	Audubon
Monona	Louisa
Dubuque	Scott
Crawford	Lee
Marshall	Hardin

The Marshall County base site, however, was ultimately not removed because the move would have been west. Such a move would have been detrimental in terms of a possible future regional Communications Center for Region 15.

Eleven (11)*counties were found in which the existing towers were excessively high. Recommendations have been made for tower height reductions in these cases. About thirty-five (35) sites required new towers (including the ten new sites) and the remaining sites were able to use existing tower height.

These recommendations are listed in Table 2-4 of Volume I. Signal reliability (SPI) contours were computed for all modes of operation state-wide to verify the decision processes.

* Table 2-4 in Volume I shows seven (7)
The additional counties with existing structures too high are: Clarke, Decatur, Greene, and Jasper.

4.2.4 CONSIDERATIONS RELATING TO THE DESIGN OF UHF MUNICIPAL SYSTEMS

The design of each of the twelve (12) UHF municipal systems was considered individually. The topography for each was examined in detail using fine grained (7-1/2') topographic maps. There is no 7-1/2' map for the Story Co. and West Des Moines/Urbandale area. The design was based upon 15' maps.

Known and existing sites were utilized to a maximum extent if they were found to be cost effective in providing the required service probability index (SPI) within the city corporate limits. Water towers, for example, are located on prominences and are usually city owned. Provided the UHF antenna is adequately isolated from the tank itself (i.e. not shadowed by it), these sites deserve serious consideration for UHF base station and satellite receiver locations.

The service probability index was that stipulated in Section 4.2.2, i.e. ninety percent (90%) with ninety-five percent (95%) time availability and a ninety percent (90%) location variability in the downtown areas and business districts with allowance of a minimum of seventy percent (70%) SPI at airports. Compared to high-band performance indices over rural traveled routes, these requirements are more stringent. This provides a contingency allowance for the portable unit when operated in the relatively less favorable, more highly propagation shadowed (by buildings, etc.) areas of the city. At the same time, the overall municipal UHF system design is based on a sound engineering basis without "overkill". "Overkill" can generally be described by SPI greater than ninety percent (90%) at regional boundaries.

For purposes of illustration, Figure 4-4 shows the 1W portable-to-base range expected in a quiet noise environment for ninety percent (90%) and seventy percent (70%) SPI and with 10 dB and 6 dB base receiver noise figures. The following conclusions may be reached from this analysis:

(1) For high SPI, very little increased range is achieved with tower heights above 150 feet. For the lower SPI, ranges increase nearly linearly with tower height.

(2) A reduction in receiver noise figure of 4 dB (10 to 6 dB), reduces the tower height requirements by a factor of two (2) at a fixed.

range. Conversely, at a constant tower height, the range increases about one (1) mile at ninety percent (90%) SPI and 1.5 miles at seventy percent (70%) SPI.

4.2.5. AIRCRAFT RADIO COMMUNICATIONS PARAMETERS

The standard SRCPP analysis method for aircraft SPI is used as in other links, however, the use of contour plot techniques is less descriptive. Figure 4-5 shows the extremely important effectivity of aircraft height upon the communications range. The potential interference range to co-frequency users is equally obvious. Accordingly, the aircraft radio unit is specified as a portable (1 to 2 watts). The range to base stations, because of an elevated antenna, is much greater than for mobile units to base stations. In order to reduce co-frequency interference and to comply with FCC Part 89.156 , it is important:

(1) To operate the aircraft at just above minimum ceilings when utilizing the radio,

(2) To keep transmissions brief and at spaced intervals.

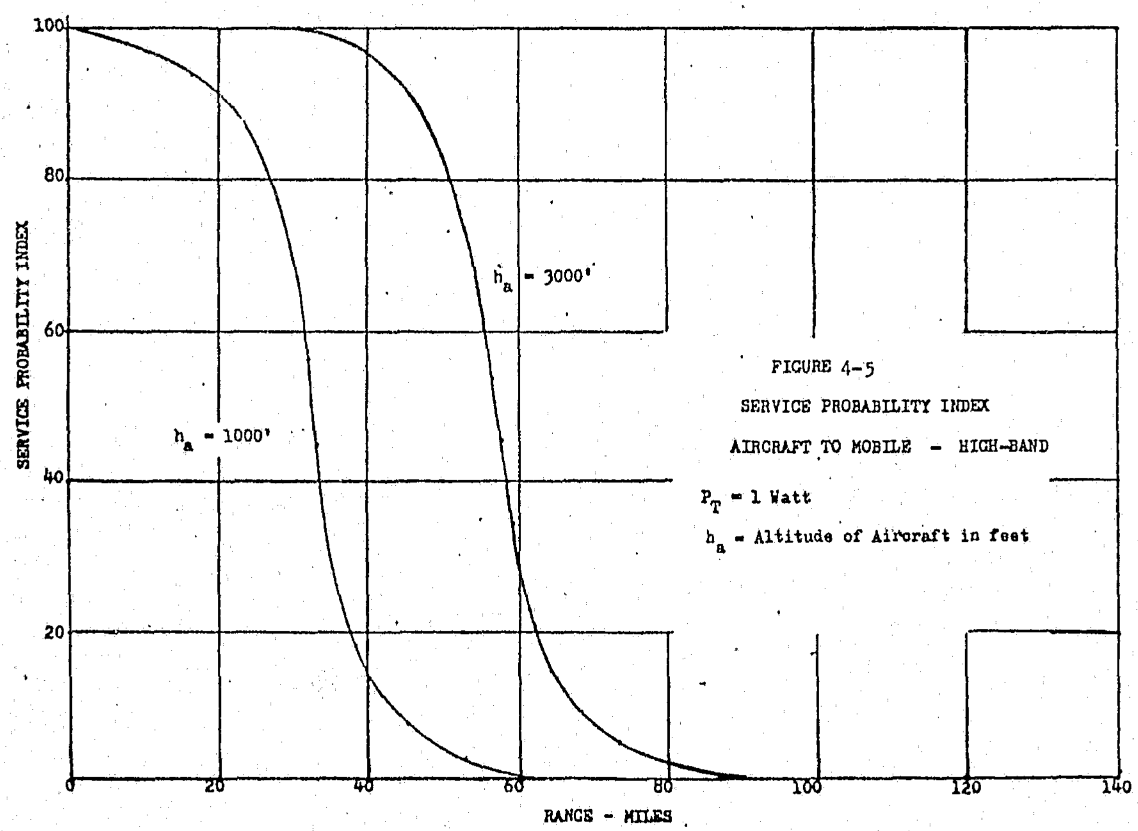

FIGURE 4-5
SERVICE PROBABILITY INDEX
AIRCRAFT TO MOBILE - HIGH-BAND

4.2.6 PORTABLE RADIO USAGE

The requirements of Section 2.2.3 (5) are met in this plan and in doing so satisfy the National Criminal Justice Standard 23.3 (4). Reference 1(h).

High-Band Portable

Specification Q in the Volume I Appendix defines the high-band portable unit for use by the city and county officers who are using the high-band radio system. The portable unit then is carried in the vehicle for charging and use whenever the primary mobile radio has priority in and is set to transmit in the Tactical Channel. It is then available to the officer when he leaves his vehicle. Channel configurations are shown in Volume I, Table 2-12 (a). Specific procurement should be based on Operations Channel selection and must be configured to be compatible with high-band mobile radios.

Different models having various power output level are available from vendors. Choice of power output depends on primary usage. The following factors should be considered when ordering:

1. Total reliable signal coverage in a county for portable-to-base operations is not economically feasible to achieve with even the more powerful units (4 watts). Base-to-portable coverage should be good within county areas but with perhaps 5% marginal area. When range is a primary consideration, the higher powered unit will reduce marginal area significantly.

2. Battery life is usually less for the more powerful units in a given duty cycle of say 5-5-90. Alternately, the weight and size of the more powerful unit is greater than the low powered unit for a given operational life and given duty cycle.

3. Aircraft operations should not use the higher powered unit. One (1) watt is recommended for that service.

4. A high-band or UHF portable unit having under two (2) watts power into the antenna may be operated on any mobile frequency in the Police Radio Service for special operations under provision of FCC Part 89.309 (c) (2).

UHF Portable Radios

Generally, the personal portable radio specification P-2, Volume I Appendix, will be the utility radio for both mobile and portable operations. The overall system design for the cities will provide reliable propagation coverage in portable-to-base and base-to-portable operations. Satellite receivers are located where the portable may not have sufficient range to reliably call through to the base (see Section 4.3.2).

The primary channel configuration selection requirements are dependent upon usage in the department and the number of UHF channels available for the implementation. Table 2-13 of Volume I indicates the selection range.

Low-Band Portable Radios

These are not recommended for use in the Iowa Plan due to the marginal antenna efficiency and its required length plus there being no way to access the Tactical (Mutual Aid) Channel with a low-band portable unit.

One-Way Calling Portable Radio

Many law enforcement agencies have supervisors and officers who may be disadvantaged both in size and cost to carry the two-way portable radio, either the VHF or UHF model. One-way voice or audible-tone-signal selective calling offers an optional flexible method for officer notification and allows calling of a specific individual, thus avoiding disturbing all persons when only one need be notified.

Establishment of this function for VHF high-band will utilize the base Information Channel frequency and utilize portable radio units designated as paging units by some manufacturers.

Transmitters and their control consoles will require a two-tone selective calling modulator to provide selective calling. The call receiver will be fixed tuned to receive the Information Channel frequency only and to decode the appropriate call sequence. Since the Information Channel is not generally monitored in the mobile or portable operational mode, there will be no disturbance of normal two-way operations. Of course, two-way calling will properly be performed on the Operations Channel and, due to cost and required reduction in available channels of the portable units to insert the demodulator, these are not selective call units.

City UHF systems may utilize the same function on the channel used for Information or on one of the least utilized channels not used for area Operations Channel functions. Coding for selective calling is an individual city project requiring cooperation only between cofrequency agencies in a metropolitan area.

It should be noted that the signal strength required for voice calling is from 6 to 20 dB greater than tone-only calling. Generally, the receiver should provide a tone-only sensitivity equal to that of the two-way portable in order to operate within the same range as for two-way portable unit.

It is recommended that the one-way tone/voice calling system be purchased when justified by agency operations plans and installed as an optional addition to the basic system and by the vendor selected for the primary installation.

Due to the fairly large differences in various vendor equipments, standard specifications are not developed in this plan for these equipments.

Tone-Sequential Coding

Tone code frequencies for a two-tone sequential selective call encoding for calling within the counties of a frequency region can be designed using eighteen (18) tones transmitted in the audible frequency range. A national (EIA or otherwise) standard does not exist for audible tone signal frequencies and vendors of such equipment have developed unique groups for local area utilization. These should be used only when compatible with the codes tabulated in the following paragraphs.

A spaced list of frequencies within the approximate range of 450 - 1200 Hz is adequate. A six percent (6%) frequency spacing between adjacent tones assigned in a simple numbering sequence of one (1) through eighteen (18) produces the following six (6) tone groups for use in each frequency region. Six tone groups allows for one group to be assigned in each county of the largest frequency region (6 counties). Regions having smaller numbers of counties may use two or more groups per county depending on total code assignment requirements.

	GROUP DESIGNATION					
	A	B	C	D	E	F
Tone Code No.	1*	1	1	1	2	5
Tone Code No.	2	6	10	14	6	9
Tone Code No.	3	7	11	15	10	13
Tone Code No.	4	8	12	16	14	17
Tone Code No.	5	9	13	17	18	18

* Assigned to the lowest tone frequency (450.0 Hz) See Table 4-13 C for nominal tone frequency assignments.

Within each group, twenty (20) unique code pairs are formed for encoder usage. A given pair will in turn sequentially modulate the Information Channel transmitter. The transmitter two-tone coded signal when received by the call receiver, having a corresponding decoder for frequency pair, will respond and signal the user that his services are required or a message awaits him at the Comm Center.

The assignment of the tone code groups A through F is made for each county within each frequency region. Each county normally will utilize one group of tones to avoid duplication of tone codes within a frequency region. Depending on the population density, however, two groups (for example, group A and B) may be utilized in a county and be incorporated into one encoder unit which could provide ninety (90) unique codes for assignment in that county.

It is recommended that the tone code groups be consistently assigned throughout each frequency region and be coordinated by the State Law Enforcement Communications Advisory Committee to ensure proper distribution and usage.

City agencies, using the UHF band, may use the same distribution of tone groups and these may be coordinated locally.

Special arrangements within agencies may be made to provide squad calling where all members of a particular squad receive calls simultaneously.

4.3 SYSTEM PERFORMANCE PREDICTION AND EVALUATION

The following narrative describes the predicted signal reliability performance of the communications system when designed, constructed and installed in accordance with the criteria of this volume and the tables of Volume I. There are many factors which may reduce the performance of a system. These include equipment specifications, system installation (antennas, connectors, and transmission lines) and tower site locations (especially MSL at selected sites). When changes are made outside of the specified ranges or system parameters a re-analysis of performance expectations is needed.

4.3.1 EVALUATION OF SYSTEM PERFORMANCE CONTOUR PLOTS (LOW-BAND AND HIGH-BAND)

Based on the system design criteria described in the preceding sections, SPI contour plots are compiled for the Iowa ninety-nine (99) county system. These are executed for low-band Operations Channel (simplex), high-band Operations (simplex) and high-band Information (half-duplex) Channels. These plots also include a display of base-to-mobile, mobile-to-base and portable-to-base modes of operations. Frames 1 through 7 show the results of the computer generated SPI plots. Two fundamental observations are noted:

(1) Contours of SPI are generally plotted on the basis of regional frequency plan boundaries corresponding to the thirty-two (32) frequency regions. The contour plots must be interpreted on the basis of these regional boundaries.

(2) The effects of base-to-base interference and base-to-mobile interference are included correctly for each region in accordance with the Operations and Information high and low-band frequency plans within the state.

The results indicate that on a frequency region basis, extremely reliable performance is obtained with neglible degrading effects of interference except for the interference produced when the base stations within the region transmit simultaneously. (Base-to-base interference is tabulated separately by county, see Table 4-5 and 4-8). It should be stressed that individual counties which have a boundary within a frequency region may experience lower performance indices with respect to their own base station than is indicated on the maps at extreme ranges. In spite of this, however, each county should experience quite adequate performance independently of adjacent counties. The single exception may be in southeastern Woodbury County near Danbury which could be served with higher reliability from Ida County.

The high-band portable performance in Frames 6 through 7 show substantially greater marginal coverage areas than the previous frames. These frames demonstrate that reliable portable-to-base performance is difficult to achieve concurrently with a mobile/base system which is cost effectively designed in accordance with the criteria stipulated in Section 4.2.2.

4.3.2 MUNICIPAL UHF SIGNAL PERFORMANCE EVALUATION

With the selection of specific sites for the UHF base stations and satellite receivers plus the additional system parameters, tower heights, antennas, powers, receiver sensitivity, etc., the service probability indices (SPI) were plotted over the map of each UHF municipality.

Municipalities reporting UHF systems were evaluated in Phase I, i.e., Davenport, Des Moines, Ankeny, Carter Lake and Waterloo. A separate re-assessment of a new system for Waterloo was undertaken, herein, since the existing system, <u>at the time of on-site survey</u> had exhibited some areas of poor performance.

The requirements for UHF municipal performance stipulated in Section 4.2.2 have been met in each case. Known existing sites were utilized when prominently located with respect to an overall optimal cost effective solution. Special attention was given antenna selection and antenna mounting configurations. UHF antennas produce severe pattern distortion when tower-side-mounted and are quite susceptible to adverse affects of guy cables. In the specifications which have been drawn, these pitfalls have been avoided. (See, for example, equipment specifications for Sioux City, Section 13.1).

The results of the performance analysis are shown in Frame 8 through Frame 21. These plots correspond to the portable-to-base or portable-to-satellite receiver modes as indicated. The label legend at each site is as follows:

B - Base

RB - Remote Base

SR - Satellite Receiver

In each case it is noted that the SPI requirements are met with the seventy percent (70%) SPI falling generally into the airport locations, which are usually beyond city boundaries. In the large municipalities, the ninety percent (90%) SPI contours are nearly tangent to each other, a desirable condition. The equipment parameters which produce the contours are shown in Table 4-14. These solutions demonstrate reliable UHF propagation coverage without producing an excessive interference potential for distant co-channel communities.

4.3.3 SITE LOCATIONS FOR A REGIONAL SYSTEM PLAN

A system design to provide regional radiating sites per regional frequency plan area is accomplished to provide a cost effective future system implementation which meets the signal reliability performance requirements set forth under Section 4.2.2. The design procedures required several computer iterations with different input of locations and of the parameters using the SRCPP SPI contour plotting method for comparison of results. Frames 22 through 26 show the low and high-band performance of the final iterations for base-to-mobile and mobile-to-base for both Operations and Information Channels. These frames include the effects of base-to-base (Operations) and base-to-mobile (Operations and Information) interference.

In general, with this plan, the SPI is quite acceptable over the entire state. A few small marginal coverage areas exist in southwest Grundy and Washington counties, southeast Decatur and Van Buren counties, and in western Crawford County. These occur only at high-band. No marginal coverage areas are indicated for low-band.

It is recommended where regional planning is done for the regions listed above that additional site location cost effectiveness and signal reliability analysis be performed based on the available sites and Comm Center city locations for the region. Insufficient information now exists to perform this analysis.

A description of each region's base and repeater assumed location site and configuration* is listed in Table 4-15.

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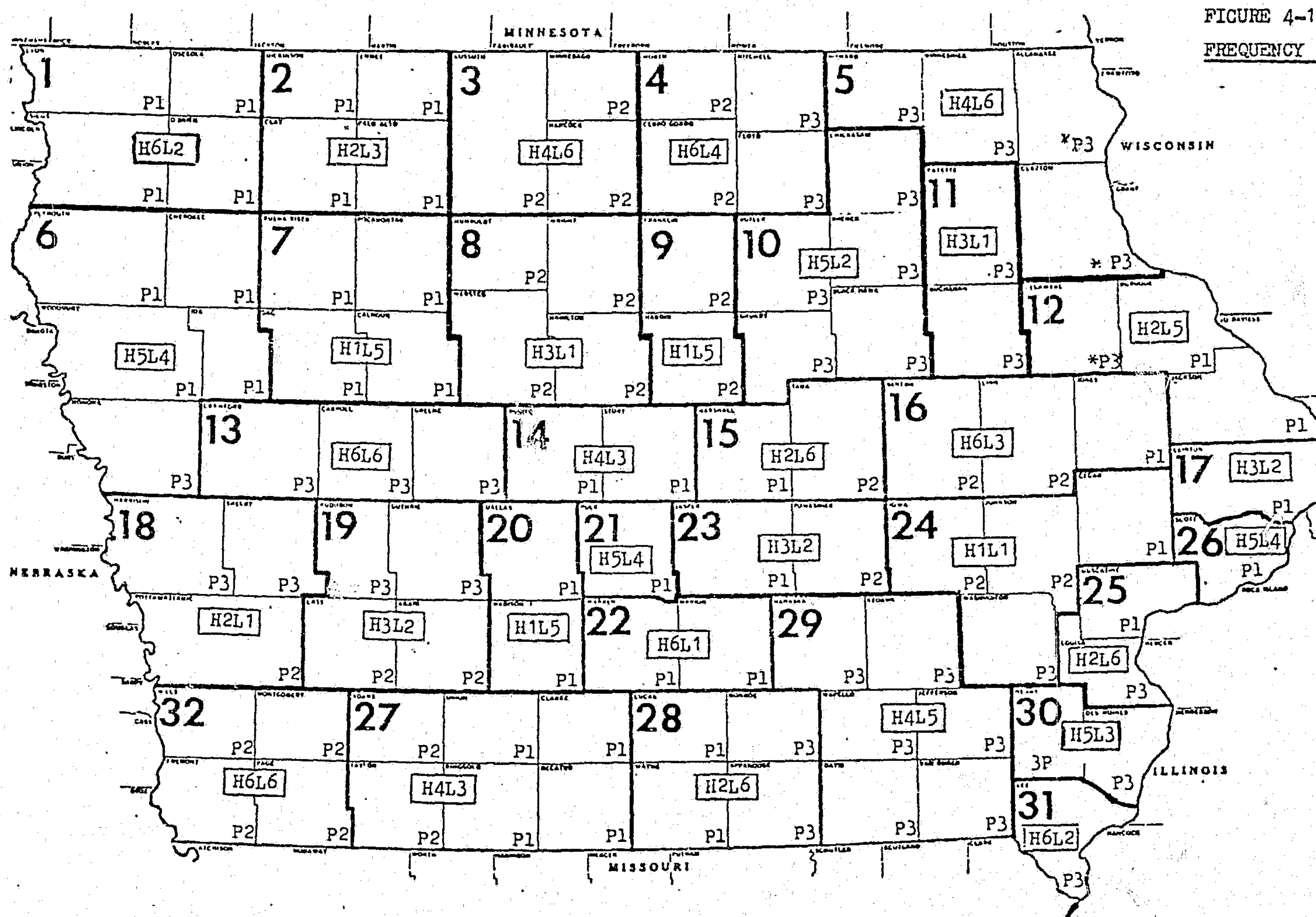
* All base and mobile transmit power levels are assumed to be 100 W output and the other parameters of Section 4.2.2 are utilized.

FIGURE 4-1

FREQUENCY PLAN



HIGH BAND REGIONAL FREQUENCY SETS

SET NO.	BASE TX/RX OPERATIONS	INFORMATION
H1	154.725	155.250
H2	154.830	155.310
H3	154.845	155.520
H4	155.010	155.535
H5	155.070	155.580
H6	155.190	155.610

LOW BAND BASE

SET NO.	OPERATIONAL
L1	37.08
L2	37.12
L3	37.14
L4	37.16
L5	37.20
L6	37.24

IHPR FREQUENCY SETS
"WIDE AREA" MOBILE IHPR

AREA NO.	TRANSM.	RECEIVE
P1	154.770	155.790
P2	154.890	155.685
P3	154.800	155.700

* This Area No. is subject to modification. Consult Highway Patrol Radio Communications Director.

Mobile Transmit 155.910 (See Table 4-7 for exceptions)
Portable Transmit 155.850 (See Table 4-7 for exceptions)

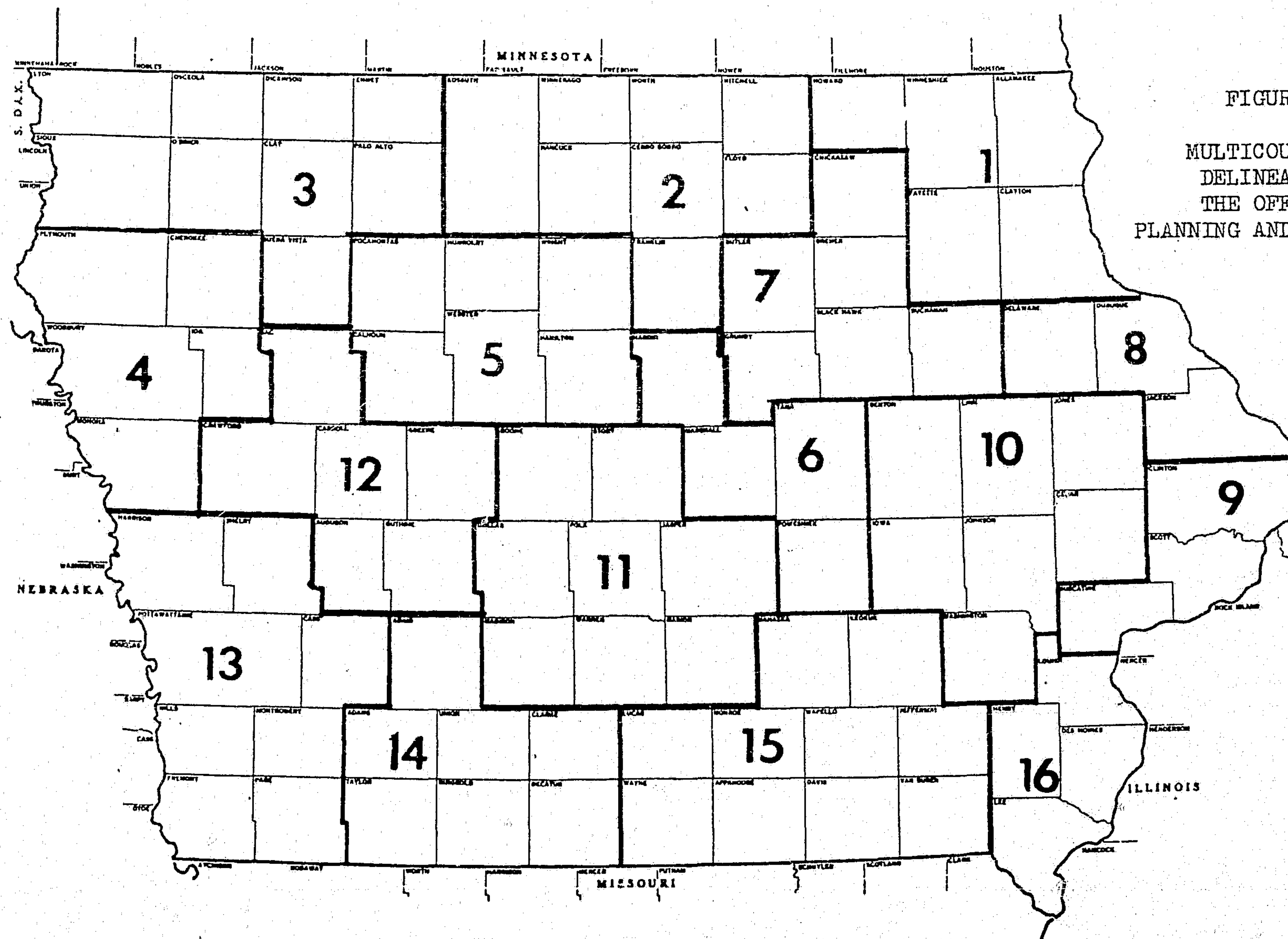


FIGURE 4 - 2

MULTICOUNTY AREAS
DELINEATED BY
THE OFFICE FOR
PLANNING AND PROGRAMMING

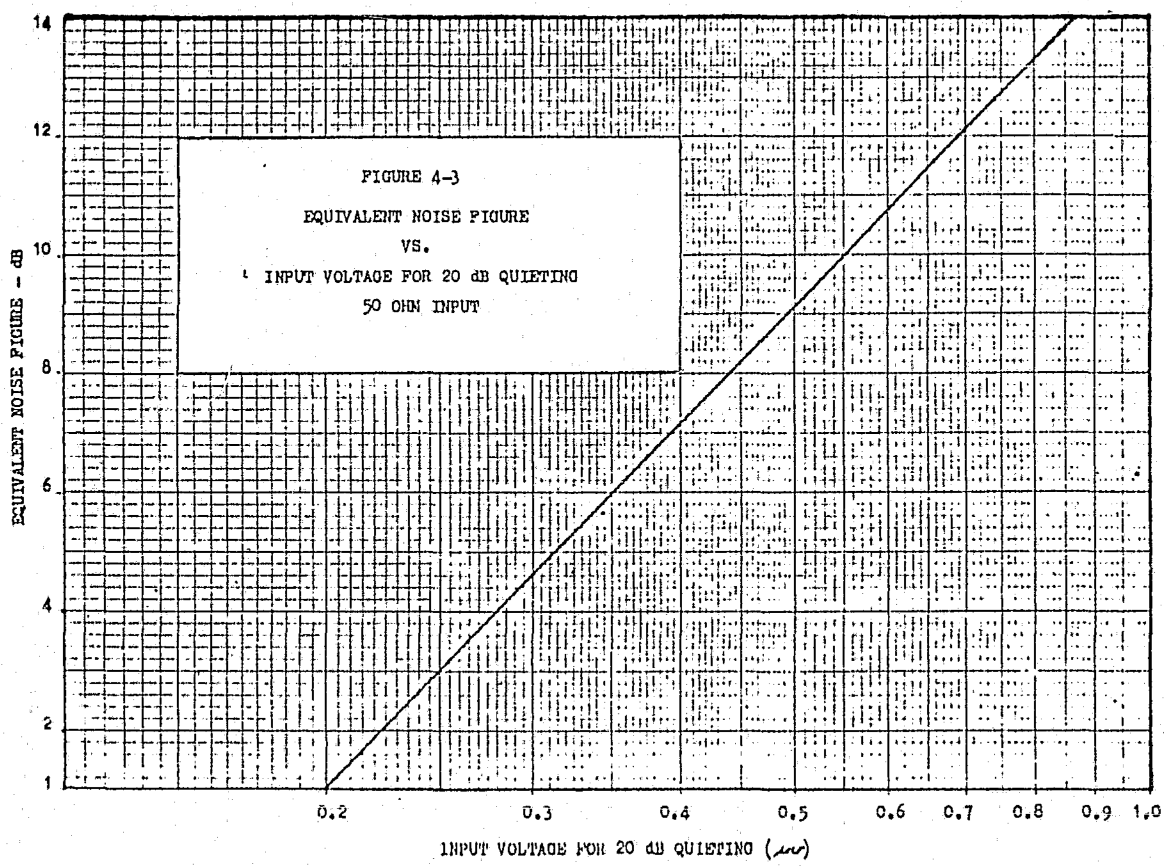


FIGURE 4-3
EQUIVALENT NOISE FIGURE
VS.
INPUT VOLTAGE FOR 20 dB QUIETING
50 OHM INPUT
EQUIVALENT NOISE FIGURE - dB
14
12
10
8
6
4
2
1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
INPUT VOLTAGE FOR 20 dB QUIETING

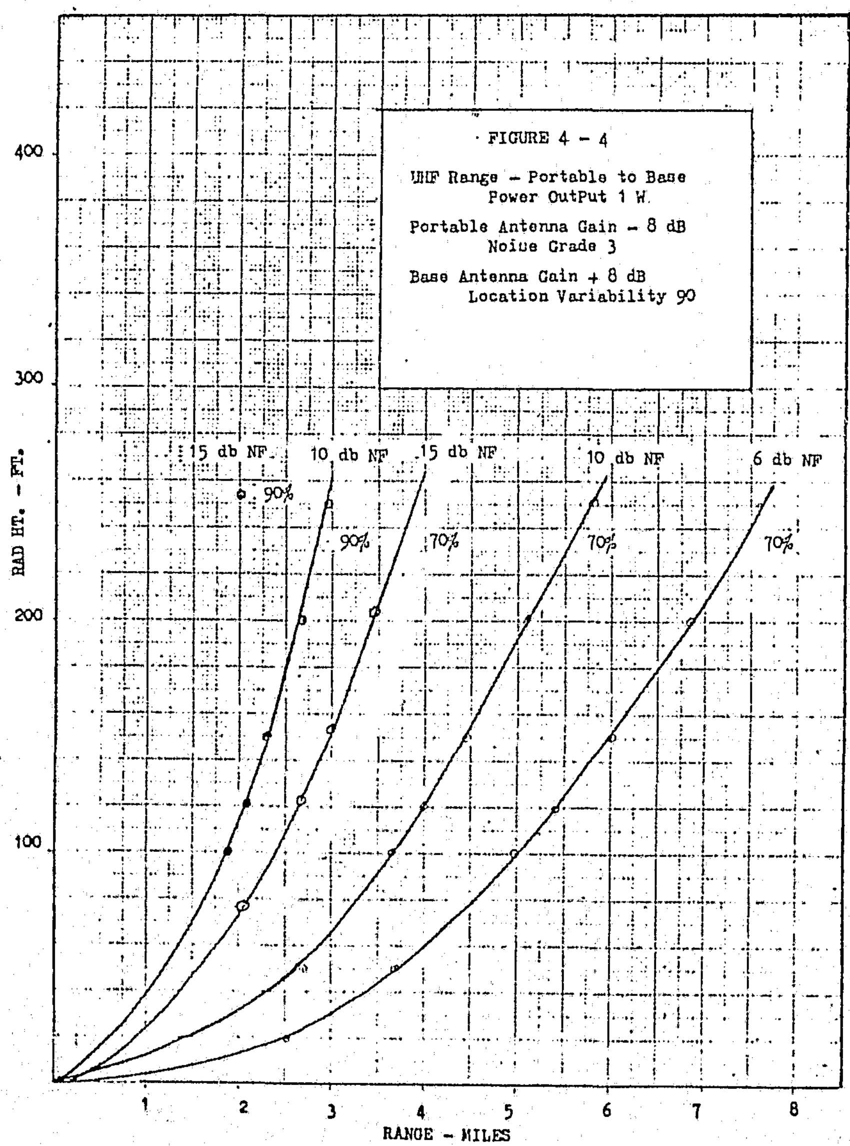


FIGURE 4 - 4
UHF Range - Portable to Base
Power OutPut 1 W.
Portable Antenna Gain - 8 dB
Noise Grade 3
Base Antenna Gain + 8 dB
Location Variability 90
15 db NF
10 db NF
15 db NF
10 db NF
6 db NF
90%
90%
70%
70%
70%
RAD HT. - FT.
400
300
200
100
1
2
3
4
5
6
7
8
RANGE - MILES

TABLE 4-1

COUNTY GROUPS FOR AREA FREQUENCY PLANNING

Regional Area No.	Pop. Class	Area Counties (Major Cities)	Rural (1) Urban (2)	Total Traffic Intensity Erlangs Radio	Telephone
1	LPD	Lyon, Osceola, O'Brien, Sioux	(1)67,413	0.25	1.17
2	LPD	Clay, Dickinson, Emmet, Palo, Alto	(1)58,327	0.197	0.82
3	LPD	Hancock, Kossuth, Winnebago	(1)49,257	0.182	0.87
4	HPD	Cerro Gordo, Floyd, Mitchell, Worth	(1)60,780	0.203	1.07
		Mason City	(2)30,491	0.153	1.250
5	LPD	Allamakee, Clayton, Howard, Winneshiek	(1)68,774	0.263	1.26
6	HPD	Cherokee, Ida, Monona, Plymouth, Woodbury	(1)79,967	0.284	1.36
		Sioux City	(2)85,925	0.573	3.58
7	LPD	Buena Vista, Calhoun, Pocahantus, Sac	(1)63,282	0.230	1.05
8	HPD	Hamilton, Humboldt, Webster, Wright	(1)65,324	0.220	0.944
		Ft. Dodge	(2)31,263	0.157	0.86
9	LPD	Franklin, Hardin	(1)35,503	0.136	0.66
10	HPD	Bremer, Blackhawk, Butler, Chickasaw, Grundy	(1)96,564	0.364	1.69
		Waterloo	(2)74,610	0.497	3.11
		Cedar Falls	(2)29,597	0.147	0.822
11	LPD	Buchanan, Fayette	(1)48,644	0.228	1.14
12	HPD	Delaware, Dubuque, Jackson	(1)67,909	0.251	1.28
		Dubuque	(2)62,309	0.417	3.44
13	LPD	Carroll, Crawford, Greene	(1)54,944	0.202	0.94
14	HPD	Boone, Story	(1)49,748	0.207	1.036
		Ames	(2)39,505	0.197	1.111
15	HPD	Marshall, Tama	(1)35,004	0.117	0.64
		Marshalltown	(2)26,219	0.130	0.722
16	HPD	Benton, Jones, Linn	(1)77,296	0.306	1.59
		Cedar Rapids	(2)110,347	0.928	6.13
		Marion	(2)18,028	0.060	0.25

TABLE 4-1 cont'd
page 2

Regional Area No.	Pop. Class	Area Counties (Major Cities)	Rural (1) Urban (2)	Total Traffic Intensity Erlangs Radio	Telephone
17	HPD	Clinton	(1)22,030	0.092	0.458
		Clinton	(2)34,719	0.173	0.965
18	HPD	Harrison, Pottawattamie, Shelby	(1)58,411	0.218	1.000
		Council Bluffs	(2)60,348	0.403	2.514
19	LPD	Adair, Audubon, Cass Guthrie	(1)48,332	0.162	0.675
20	LPD	Dallas, Madison	(1)37,643	0.148	0.711
21	HPD	Polk County	(1)45,331	0.183	0.92
		Des Moines	(2)200,587	1.671	11.14
		(W. Heights, Urbandale, Clive, W. Des Moines)	(2)40,183	0.200	1.16
22	LPD	Marion, Warren	(1)53,784	0.212	1.058
23	LPD	Jasper, Poweshiek	(1)54,228	0.211	0.989
24	HPD	Cedar, Iowa, Johnson, Washington	(1)81,283	0.278	1.27
		Iowa City	(2)46,850	0.223	1.30
25	HPD	Muscatine, Louisa	(1)25,458	0.087	0.333
		Muscatine	(2)22,405	0.113	0.622
26	HPD	Scott	(1)22,092	0.092	0.433
		Davenport	(2)98,469	0.656	4.103
		Bettendorf	(2)22,126	0.092	0.614
27	LPD	Adams, Clarke, Decatur, Ringgold, Taylor, Union	(1)52,360	0.178	0.739
28	LPD	Appanoose, Lucas, Monroe, Wayne	(1)48,932	0.156	0.847
29	HPD	Davis, Jefferson, Keokuk, Mahaska, Van Buren Wapello	(1)81,283	0.296	1.23
		Ottumwa	(2)29,610	0.147	0.417
30	HPD	Henry, Des Moines	(1)32,730	0.110	0.453
		Burlington	(2)32,366	0.160	0.900
31	LPD	Lee	(1)14,369	0.048	0.199
		Keokuk	(2)14,631	0.049	0.203
		Fort Madison	(2)13,996	0.047	0.194
32	LPD	Mills, Montgomery, Fremont, Page	(1)52,176	0.178	0.917

Note: LPD Denotes low population density groups.
HPD Denotes high population density groups.

TABLE 4-2 COMM CENTER INFORMATION DETAIL

COMM CTR. LOCATION COUNTY.	FREQ. AREA	COMM CENTER DESIGNATION COUNTY - CITY	REQUIRED NUMBER OF OPERATIONS CHANNELS	REQUIRED NUMBER OF INFORMATIONS CHANNELS	RADIO DISPATCH POSITIONS #	EMERGENCY REQUEST TELEPHONE LINES #	OPERATORS COMBINED RADIO/TELE	OPERATORS TELE	MANNING REQUIRED PEAK SHIFT	MANNING REQUIRED DAILY STAFF	MANNING REQUIRED DISPATCH STAFF TOTAL
1	19	ADAIR	1	1	1	2	1		1	3	5
2	27	ADAMS	1	1	1	2	1		1	3	5
3	5	ALLAMAKEE	1	1	1	3	1		1	3	5
4	28	APPANOOSE	1	1	1	3	1		1	3	5
5	19	AUDUBON	1	1	1	2	1		1	3	5
6	16	BENTON	1	1	2	3	2		2	5	7
7	10	BLACKHAWK	1	1	2	4	2		2	5	7
7	10	WATERLOO	2	2	4	10	3	1	4	8	12
7	10	CEDAR FALLS	1		1	5	1	1	2	5	7
8	14	BOONE	1	1	2	3	2		2	5	7
9	10	BREMER	1	1	2	3	2		2	5	7
10	11	BUCHANAN	1	1	2	3	2		2	5	7
11	7	BUENA VISTA	1	1	2	3	2		2	5	7
12	10	BUTLER	1	1	2	3	2		2	4	6
13	7	CALHOUN	1	1	1	3	1		2	4	6
14	13	CARROLL	1	1	2	3	2		1	3	5
15	19	CASS	1	1	2	3	2		2	5	7
16	24	CEDAR	1	1	2	3	2		2	4	6
17	4	CERRO GORDO-MASON CITY	2	1	3	7	2	1	3	7	10
18	6	CHEROKEE	1	1	2	3	2		2	4	6
19	10	CHICKASAW	1	1	1	3	1		1	3	5
20	27	CLARKE	1	1	1	2	1		1	3	5
21	2	CLAY	1	1	2	3	2		2	4	6
22	5	CLAYTON	1	1	2	3	2		2	4	6
23	17	CLINTON-CLINTON	2	1	3	7	2	1	3	8	12
24	13	CRAWFORD	1	1	2	3	2		2	4	6
25	20	DALLAS	1	1	2	3	2		2	5	7
26	29	DAVIS	1	1	1	2	1		1	3	5
27	27	DECATUR	1	1	1	2	1		1	3	5
28	12	DELAWARE	1	1	2	3	2		2	4	6
29	30	DES MOINES-BURLINGTON	2	1	3	7	2	1	3	7	10
30	2	DICKINSON	1	1	1	3	1		1	3	5
31	12	DUBUQUE CO.	1	1	2	4	2		2	5	7
31	12	DUBUQUE CITY	2	1	4	11	3	1	4	1	12
32	2	EMMET	1	1	1	3	1		1	3	5
33	11	FAYETTE	1	1	2	4	2		2	5	7

TABLE 4-2 page 2

COMM CTR LOCATION COUNTY FREQ	AREA	COMM CENTER DESIGNATION COUNTY – CITY	REQUIRED NUMBER OF OPERATIONS CHANNELS	REQUIRED NUMBER OF INFORMATION CHANNELS	RADIO DISPATCH POSITIONS #	EMERGENCY TELEPHONE LINES #	OPERATORS COMBINED RADIO/TELE	TELE	MANNING REQUIRED PEAK SHIFT	MANNING REQUIRED DAILY STAFF	MANNING REQUIRED DISPATCH STAFF TOTAL
34	4	FLOYD	1	1	2	3	2		2	4	6
35	9	FRANKLIN	1	1	1	3	1		1	3	5
36	18	FREMONT	1	1	1	2	1		1	3	5
37	13	GREENE	1	1	1	3	1		1	3	5
38	10	GRUNDY	1	1	1	3	1		1	3	5
39	19	GUTHRIE	1	1	1	3	1		1	3	5
40	8	HAMILTON	1	1	2	3	2		2	4	6
41	3	HANCOCK	1	1	1	3	1		1	3	5
42	9	HARDIN	1	1	2	3	2		2	4	6
43	18	HARRISON	1	1	2	3	2		2	4	6
44	30	HENRY	1	1	2	3	2		2	4	6
45	5	HOWARD	1	1	1	3	1		1	3	5
46	8	HUMBOLDT	1	1	1	3	1		1	3	5
47	6	IDA	1	1	1	2	1		1	3	5
48	24	IOWA	1	1	2	3	2		2	4	6
49	12	JACKSON	1	1	2	3	2		2	4	6
50	23	JASPER	1	1	2	4	2		2	5	7
51	29	JEFFERSON	1	1	2	3	2		2	4	6
52	24	JOHNSON	1	1	2	3	2		2	5	6
52.	24	IOWA CITY	1	1	3	6	2	1	3	6	9
53	16	JONES	1	1	2	3	2		2	4	6
54	29	KEOKUK	1	1	1	3	1		1	3	5
55	3	KOSSUTH	1	1	2	3	2		2	4	6
56	31	LEE	1	1	2	5	2		2	6	9
57	16	LINN	1	1	2	4	2		2	5	7
57	16	CEDAR RAPIDS	3	2	5	15	4	2	7	14	21
57	16	MARION	1		1	3	2		2	4	6
58	25	LOUISA	1	1	1	2	1		1	3	5
59	28	LUCAS	1	1	2	3	2		2	4	6
60	1	LYON	1	1	1	3	1		1	3	5
61	20	MADISON	1	1	1	3	1		1	3	5
62	29	MAHASKA	1	1	2	3	2		2	5	7
63	22	MARION	1	1	2	3	2		2	5	7
64	15	MARSHALL-MARSHALLTOWN	2	1	2	5	2		2	6	9
65	18	MILLS	1	1	2	3	2		2	5	7
66	4	MITCHELL	1	1	2	3	2		2	5	7
67	6	MONONA	1	1	2	3	2		2	4	6

TABLE 4-2 page 3

COMM CTR LOCATION COUNTY FREQ	AREA	COMM CENTER DESIGNATION COUNTY - CITY	REQUIRED NUMBER OF OPERATIONS CHANNELS	REQUIRED NUMBER OF INFORMATION CHANNELS	RADIO DISPATCH POSITIONS #	EMERGENCY TELEPHONE LINES #	OPERATORS COMBINED RADIO/TELE	OPERATORS TELE	MANNING REQUIRED PEAK SHIFT	MANNING REQUIRED DAILY STAFF	MANNING REQUIRED DISPATCH STAFF TOTAL
68	28	MONROE	1	1	2	3	2		2	5	7
69	18	MONTGOMERY	1	1	1	2	1		1	3	5
70	25	MUSCATINE-MUSCATINE	2	1	2	4	2		2	5	7
71	1	O'BRIEN	1	1	2	3	2		2	4	6
72	1	OSCEOLA	1	1	1	2	1		1	3	5
73	18	PAGE	1	1	2	3	2		2	4	6
74	2	PALO ALTO	1	1	1	3	1		1	3	5
75	6	PLYMOUTH	1	1	2	3	2		2	4	6
76	7	POCAHONTAS	1	1	1	3	1		1	3	5
77	21	POLK	1	1	2	5	2		2	6	9
		DES MOINES	4	4	5	18	5	3	8	18	26
		W. DES MOINES (W HTS. CLIVE, URBANDALE)	1	1	2	6	2	1	3	6	9
78	18	POTTAWATTAMIE	1	1	2	4	2		2	5	7
		COUNCIL BLUFFS	2	1	3	9	3	1	4	9	13
79	23	POWESHIEK	1	1	2	3	2		2	4	6
80	27	RINGGOLD	1	1	1	2	1		1	3	5
81	7	SAC	1	1	2	3	2		2	4	6
82	26	SCOTT	1	1	2	3	2		2	5	7
82	26	DAVENPORT	2	2	4	12	3	2	5	11	17
82	26	BETTENDORF	1		2	5	2		2	4	6
83	18	SHELBY	1	1	2	3	2		2	4	6
84	1	SIOUX	1	1	2	4	2		2	5	7
85	14	STORY	1	1	2	3	2		2	5	7
	14	AMES	1		2	6	2	1	3	6	9
86	15	TAMA	1	1	2	3	2		2	4	6
87	27	TAYLOR	1	1	1	2	1		1	3	5
88	27	UNION	1	1	1	3	1		1	3	5
89	29	VAN BUREN	1	1	1	2	1		1	3	5
90	29	WAPELLO-OTTUMWA	2	1	2	4	2		2	5	7
91	22	WARREN	1	1	2	4	2		2	4	6
92	24	WASHINGTON	1	1	2	3	2		2	4	6
93	28	WAYNE	1	1	1	2	1		1	3	5
94	8	WEBSTER-FORT DODGE	2	1	2	6	2	1	3	6	9
95	3	WINNEBAGO	1	1	1	3	1		1	3	5
96	5	WINNESHIEK	1	1	2	3	2		2	5	7
97	6	WOODBURY	1	1	2	3	2		2	4	6
	6	SIOUX CITY	2	2	3	11	3	2	5	11	16
98	4	WORTH	1	1	1	2	1		1	3	5
99	8	WRIGHT	1	1	2	3	2		2	4	6

TABLE 4-3 OPERATIONS/INFORMATION CHANNEL LINK REQUIREMENTS BASED ON TOTAL RADIO TRAFFIC INTENSITY

A. OPERATIONS CHANNEL

Range of Total Radio Intensity (Erlangs)			Number of Required Links
.05	to	0.35	1
0.35	to	0.75	2
0.75	to	1.3	3
1.3	to	2.0	4
2.0	to	3.0	5

B. INFORMATION CHANNEL

Range of Total Radio Intensity (Erlangs)			Number of Required Links
0.05	to	0.5	1
0.5	to	1.0	2
1.0	to	1.5	3
1.5	to	3.0	4

TABLE 4-5 LOW-BAND BASE-TO-BASE INTERFERENCE REDUCTION FACTORS

37.08 MHz

County No.	Base Location	IRF
46	Dakota City	.998571
99	Clarion	.997258
94	Fort Dodge	.994726
40	Webster City	.997857
33	West Union	.996970
10	Independence	.989637
43	Logan	.999184
83	Harlan	.997947
78	Council Bluffs	.998526
91	Indianola	.996400
63	Knoxville	.991791
48	Marengo	.989839
52	Iowa City	.995687
16	Tipton	.994320
92	Washington	.995627

37.12 MHz

County No.	Base Location	IRF
60	Rock Rapids	.999913
72	Sibley	.999797
71	Pringhar	.999579
84	Orange City	.999896
9	Waverly	.998422
12	Allison	.997784
38	Grundy Center	.975132
7	Waterloo	.999063
19	New Hampton	.998788
23	Clinton	.997676
5	Audubon	.998306
39	Guthrie Center	.997157
15	Atlantic	.998285
1	Greenfield	.996688
50	Newton	.980781
~~79~~	~~Montezuma~~	~~.989361~~
56	Fort Madison	.997876

37.14 MHz

County No.	Base Location	IRF
96	Spencer	.9996[illegible]
30	Spirit Lake	.9999[illegible]
32	Estherville	.9997[illegible]
74	Emmetsburg	.99921
8	Boone	.99777
85	Nevada	.99752
6	Vinton	.99947
57	Cedar Rapids	.99996
53	Anamosa	.99959
2	Corning	.99982
88	Creston	.99864
20	Osceola	.99594
87	Bedford	.99995
80	Mt. Ayr	.99988
27	Leon	.99794
~~44~~	~~Mt. Pleasant~~	~~.99793~~
29	Burlington	.99886

37.16 MHz

County No.	Base Location	IRF
17	Mason City	.999078
34	Charles City	.999054
66	Osage	.999725
98	Northwood	.999795
18	Cherokee	.999050
47	Ida Grove	.999057
67	Onawa	.999711
75	LeMars	1.000000
97	Sioux City	1.000000
77	Des Moines	.999978
82	Davenport	.999876

37.20 MHz

County No.	Base Location	IRF
11	Storm Lake	.999553
76	Pocahontas	.998091
81	Sac City	.998977
13	Rockwell City	.993890
35	Hampton	.995796
42	Eldora	.995435
28	Manchester	.997661
31	Dubuque	.999052
49	Maquoketa	.998747
61	Winterset	.998790
25	Adel	.995444
62	Oskaloosa	.997843
54	Sigourney	.997377
90	Ottumwa	.999517
51	Fairfield	.998676
26	Bloomfield	.998976
89	Keosaugua	.999721

37.24 MHz

County No.	Base Location	IRF
41	Garner	.99741
55	Algona	.99758
95	Forest City	.99883
3	Waukon	.99934
22	Elkader	.99811
45	Cresco	.99779
96	Decorah	.99890
24	Denison	.99523
14	Carroll	.99765
37	Jefferson	.9969[illegible]
64	Marshalltown	.99993
86	Toledo	.99396
65	Glenwood	.99801
69	Red Oak	.99486
36	Sidney	.99885
73	Clarinda	.9990[illegible]
70	Muscatine	.99788
58	Wapello	.99749
59	Chariton	.9961[illegible]
68	Albia	.99555
93	Corydon	.99801
4	Centerville	.99889

TABLE 4-7 CHANNEL AND CTCS FREQUENCIES - COUNTY SYSTEMS

COUNTY	REG	COUNTY (CO. SEAT)	BASE STATION TX/RX LOW-BAND OPERATIONS	BASE STATION TX/RX HIGH-BAND OPERATIONS	BASE STATION TX HIGH-BAND INFORMATION	BASE STATION CTCS** FREQUENCY Hz	MOBILE TX WIDE AREA	MOBILE RX WIDE AREA	MOBILE WIDE AREA* CTCS Freq.	MOBILE TX INFORMATION	PORTABLE TX
1	19	ADAIR (GREENFIELD)	37.12	154.845	155.520	146.2	154.890	155.685	146.2/192.8	155.910	155.850
2	27	ADAMS (CORNING)	37.14	155.010	155.535	137.3	154.890	155.685	146.2	"	"
3	5	ALLAMAKEE (WAUKON)	37.24	155.010	155.535	167.9	154.800	155.700	192.8	"	"
4	28	APPANOOSE (CENTERVILLE)	37.24	154.830	155.310	167.9	154.800	155.700	146.2	"	"
5	19	AUDUBON (AUDUBON)	37.12	154.845	155.520	146.2	154.800	155.700	127.3/192.8	"	"
6	16	BENTON (VINTON)	37.14	155.190	155.610	192.8	154.890	155.685	167.9	"	"
7	10	BLACKHAWK (WATERLOO)	37.12	155.070	155.580	167.9	154.800	155.700	146.2	"	"
8	14	BOONE (BOONE)	37.14	155.010	155.535	167.9	154.770	155.790	146.2	"	"
9	10	BREMER (WAVERLY)	37.12	155.070	155.580	167.9	154.800	155.700	146.2	"	"
10	11	BUCHANAN (INDEPENDENCE)	37.08	154.845	155.520	127.3	154.800	155.700	146.2	"	"
11	7	BUENA VISTA (STORM LAKE)	37.20	154.725	155.250	167.9	154.770	155.790	127.3	"	"
12	10	BUTLER (ALLISON)	37.12	155.070	155.580	167.9	154.800	155.700	146.2	"	"
13	7	CALHOUN (ROCKWELL CITY)	37.20	154.725	155.250	167.9	154.770	155.790	127.3	"	"
14	13	CARROLL (CARROLL)	37.24	155.190	155.610	192.8	154.800	155.700	127.3	"	"
15	19	CASS (ATLANTIC)	37.12	154.845	155.520	146.2	154.890	155.685	146.2	"	"
16	24	CEDAR (TIPTON)	37.08	154.725	155.250	167.9	154.770	155.790	167.9	"	"
17	4	CERRO GORDO (MASON CITY)	37.16	155.190	155.610	192.8	154.890	155.685	127.3	"	"
18	6	CHEROKEE (CHEROKEE)	37.16	155.070	155.580	146.2	154.770	155.790	127.3	"	"
19	10	CHICKASAW (NEW HAMPTON)	37.12	155.070	155.580	167.9	154.800	155.700	146.2/167.9	"	"
20	27	CLARKE (OSCEOLA)	37.14	155.010	155.535	127.3	154.770	155.790	127.3	"	"
21	2	CLAY (SPENCER)	37.14	154.830	155.310	1[illegible].2	154.770	155.790	127.3/192.8	"	"
22	5	CLAYTON (ELKADER)	37.24	155.010	155.535	167.9	154.800	155.700	192.8	"	"
23	17	CLINTON (CLINTON)	37.12	154.845	155.520	146.2	154.770	155.790	167.9	"	"
24	13	CRAWFORD (DENISON)	37.24	155.190	155.610	192.8	154.800	155.700	127.3	"	"
25	20	DALLAS (ADEL)	37.20	154.725	155.250	192.8	154.770	155.790	146.2	"	"
26	29	DAVIS (BLOOMFIELD)	37.20	155.010	155.535	146.2	154.800	155.700	167.9	"	"
27	27	DECATUR (LEON)	37.14	155.010	155.535	127.3	154.770	155.790	127.3	"	"
28	12	DELAWARE (MANCHESTER)	37.20	154.830	155.310	192.8	154.800	155.700	127.3	"	"
29	30	DES MOINES (BURLINGTON)	37.14	155.070	155.580	146.2	154.[illegible]	155.700	127.3	"	"
30	2	DICKENSON (SPIRIT LAKE)	37.14	154.830	155.310	146.2	154.770	155.790	192.8	"	"
31	12	DUBUQUE (DUBUQUE)	37.20	154.830	155.310	192.8	154.770	155.790	167.9	"	"
32	2	EMMET (ESTERVILLE)	37.14	154.830	155.310	146.2	154.770	155.790	192.8		
33	11	FAYETTE (WEST UNION)	37.08	154.845	155.520	127.3	154.800	155.700	146.2/192.8	155.910	155.850
34	4	FLOYD (CHARLES CITY)	37.16	155.190	155.610	192.8	154.800	155.700	146.2/167.9	"	"
35	9	FRANKLIN (HAMPTON)	37.20	154.725	155.250	127.3	154.890	155.685	127.3	"	"

NOTE: All Tx and Rx frequencies are in megahertz (MHz)

*This frequency (2 required on occasion) is subject to some modification depending upon IHPR planning.

** CTCS frequencies listed are those assigned for base, mobile, and portable use in channels other than Wide-Area Channels.

TABLE 4-7 page 2 CHANNEL AND CTCS FREQUENCIES

			BASE STATION				MOBILE				PORTABLE
COUNTY	REG	COUNTY (CO. SEAT)	TX/RX LOW-BAND OPERATIONS	TX/RX HIGH-BAND OPERATIONS	TX HIGH-BAND INFORMATION	CTCS** FREQUENCY Hz	TX WIDE AREA MOBILE	RX WIDE AREA MOBILE	WIDE AREA* CTCS Hz	TX INFORMATION MOBILE	TX
36	18	FREMONT (SIDNEY)	37.24	155.190	155.610	167.9	154.890	155.685	192.8	155.910	155.850
37	13	GREENE (JEFFERSON)	37.24	155.190	155.610	192.8	154.800	155.700	192.8	"	"
38	10	GRUNDY (GRUNDY CENTER)	37.12	155.070	155.580	167.9	154.800	155.700	146.2	"	"
39	19	GUTHRIE (GUTHRIE CENTER)	37.12	154.845	155.520	146.2	154.800	155.700	192.8	"	"
40	8	HAMILTON (WEBSTER CITY)	37.08	154.845	155.520	146.2	154.890	155.685	146.2	"	"
41	3	HANCOCK (GARNER)	37.24	155.010	155.535	127.3	154.890	155.685	127.3	"	"
42	9	HARDIN (ELDORA)	37.20	154.725	155.250	127.3	154.890	155.685	146.2	"	"
43	18	HARRISON (LOGAN)	37.08	154.830	155.310	167.9	154.800	155.700	146.2	"	"
44	30	HENRY (MT. PLEASANT)	37.14	155.070	155.580	146.2	154.800	155.700	167.9	"	"
45	5	HOWARD (CRESCO)	37.24	155.010	155.535	167.9	154.800	155.700	167.9	155.850	155.970/156.03
46	8	HUMBOLDT (DAKOTA CITY)	37.08	154.845	155.520	146.2	154.890	155.685	127.3	155.910	155.850
47	6	IDA (IDA GROVE)	37.16	155.070	155.580	146.2	154.770	155.790	127.3	"	"
48	24	IOWA (MARENGO)	37.08	154.725	155.250	167.9	154.890	155.685	167.9/192.8	"	"
49	12	JACKSON (MAQUOKETA)	37.20	154.830	155.310	192.8	154.770	155.790	167.9	"	"
50	23	JASPER (NEWTON)	37.12	154.845	155.520	192.8	154.770	155.790	146.2	"	"
51	29	JEFFERSON (FAIRFIELD)	37.20	155.010	155.535	146.2	154.800	155.700	167.9	"	"
52	24	JOHNSON (IOWA CITY)	37.08	154.725	155.250	167.9	154.890	155.685	167.9	"	"
53	16	JONES (ANAMOSA)	37.14	155.190	155.610	192.8	154.770	155.790	167.9	"	"
54	29	KEOKUK (SIGOURNEY)	37.20	155.010	155.535	146.2	154.800	155.700	167.9	"	"
55	3	KOSSUTH (ALGONA)	37.24	155.010	155.535	127.3	154.890	155.685	127.3	155.910	155.910 or 155.97/156.03
56	31	LEE (FORT MADISON)	37.12	155.190	155.610	127.3	154.800	155.700	127.3/167.9	"	155.850
57	16	LINN (CEDAR RAPIDS)	37.14	155.190	155.610	192.8	154.890	155.685	167.9	"	"
58	25	LOUISA (WAPELLO)	37.24	154.830	155.310	127.3	154.800	155.700	127.3/167.9	"	"
59	28	LUCAS (CHARITON)	37.24	154.830	155.310	167.9	154.770	155.790	127.3	"	"
60	1	LYON (ROCK RAPIDS)	37.12	155.190	155.610	127.3	154.770	155.790	167.9	"	"
61	20	MADISON (WINTERSET)	37.20	154.725	155.250	192.8	154.770	155.790	146.2	"	"
62	29	MAHASKA (OSKALOOSA)	37.20	155.010	155.535	146.2	154.800	155.700	146.2	"	"
63	22	MARION (KNOXVILLE)	37.08	155.190	155.610	146.2	154.770	155.790	146.2	"	"
64	15	MARSHALL (MARSHALLTOWN)	37.24	154.830	155.310	146.2	154.770	155.790	146.2	"	"
65	18	MILLS (GLENWOOD)	37.24	155.190	155.610	167.9	154.890	155.685	192.8	"	"
66	4	MITCHELL (OSAGE)	37.16	155.190	155.610	192.8	154.800	155.700	167.9	155.850	155.970/156.03
67	6	MONONA (ONAWA)	37.16	155.070	155.580	146.2	154.800	155.700	146.2	155.910	155.850
68	28	MONROE (ALBIA)	37.24	154.830	155.310	167.9	154.800	155.700	146.2	"	"
69	18	MONTGOMERY (RED OAK)	37.24	155.190	155.610	167.9	154.890	155.685	146.2	"	"
70	25	MUSCATINE (MUSCATINE)	37.24	154.830	155.310	127.3	154.770	155.790	127.3	"	"
71	1	O'BRIEN (PRIMGHAR)	37.12	155.190	155.610	127.3	154.770	155.790	127.3/167.9	155.910	155.850
72	1	OSCEOLA (SIBLEY)	37.12	155.190	155.610	127.3	154.770	155.790	167.9	"	"
73	18	PAGE (CLARINDA)	37.24	155.190	155.610	167.9	154.890	155.685	127.3	"	"
74	2	PALO ALTO (EMMETSBURG)	37.14	154.830	155.310	146.2	154.770	155.790	127.3/192.8	"	"
75	6	PLYMOUTH (LE MARS)	37.16	155.070	155.580	146.2	154.770	155.790	146.2	"	"
76	7	POCAHONTAS (POCAHONTAS)	37.20	154.725	155.250	167.9	154.770	155.790	127.3	"	"
77	21	POLK (DES MOINES)	37.16	155.070	155.580	167.9	154.770	155.790	146.2	"	"
78	18	POTTAWATTAMIE (COUNCIL BLUFFS)	37.08	154.830	155.310	167.9	154.890	155.685	146.2/192.8	"	"
79	23	POWESHIEK (MONTEZUMA)	37.12	154.845	155.520	192.8	154.890	155.685	192.8	"	"
80	27	RINGGOLD (MT. AYR)	37.14	155.010	155.535	127.3	154.770	155.790	127.3	"	"

NOTE .11 'x and

TABLE 4-7 page 3 CHANNEL AND CTCS FREQUENCIES

			BASE STATION				MOBILE				PORTABLE
COUNTY	REG	COUNTY (CO.SEAT)	TX/RX LOW-BAND OPERATIONS	TX/RX HIGH-BAND OPERATIONS	TX HIGH-BAND INFORMATION	CTCS ** FREQUENCY Hz	TX WIDE AREA MOBILE	RX WIDE AREA MOBILE	WIDE AREA* CTCS Hz	TX INFORMATION MOBILE	TX
81	7	SAC (SAC CITY)	37.20	154.725	155.250	167.9	154.770	155.790	127.3	155.910	155.850
82	26	SCOTT (DAVENPORT)	37.16	155.070	155.580	127.3	154.770	155.790	167.9	"	"
83	18	SHELBY (HARLAN)	37.08	154.830	155.310	167.9	154.800	155.700	127.3	"	"
84	1	SIOUX (ORANGE CITY)	37.12	155.190	155.610	127.3	154.770	155.790	146.2/167.9	"	"
85	14	STORY (NEVADA)	37.14	155.010	155.535	167.9	154.770	155.790	146.2	"	"
86	15	TAMA (TOLEDO)	37.24	154.830	155.310	146.2	154.890	155.685	167.9/192.8	"	"
87	27	TAYLOR (BEDFORD)	37.14	155.010	155.535	127.3	154.890	155.685	127.3	"	"
88	27	UNION (CRESTON)	37.14	155.010	155.535	127.3	154.770	155.790	127.3	"	"
89	29	VAN BUREN (KEOSAUQUA)	37.20	155.010	155.535	146.2	154.800	155.700	167.9	"	"
90	29	WAPELLO (OTTUMWA)	37.20	155.010	155.535	146.2	154.800	155.700	167.9	"	"
91	22	WARREN (INDIANOLA)	37.08	155.190	155.610	146.2	154.770	155.790	146.2	"	"
92	24	WASHINGTON (WASHINGTON)	37.08	154.725	155.250	167.9	154.800	155.700	167.9	"	"
93	28	WAYNE (CORYDON)	37.24	154.830	155.310	167.9	154.770	155.790	127.3	"	"
94	8	WEBSTER (FT. DODGE)	37.08	154.845	155.520	146.2	154.890	155.685	146.2	"	"
95	3	WINNEBAGO (FOREST CITY)	37.24	155.010	155.535	127.3	154.890	155.685	127.3	"	"
96	5	WINNESHIEK (DECORAH)	37.24	155.010	155.535	167.9	154.800	155.700	167.9	"	"
97	6	WOODBURY (SIOUX CITY)	37.16	155.070	155.580	146.2	154.770	155.790	127.3/146.2	"	"
98	4	WORTH (NORTHWOOD)	37.16	155.190	155.610	192.8	154.890	155.685	127.3	"	"
99	8	WRIGHT (CLARION)	37.08	154.845	155.520	146.2	154.890	155.685	127.3	"	"

NOTE: All Tx and Tx frequencies are in megahertz (MHz)

* This frequency (2 required on occasion) is subject to some modification depending upon IHPR planning.

** CTCS frequencies listed are those assigned for base, mobile, and portable use in channels other than Wide-Area Channels.

Table 4-8 HIGH-BAND BASE-TO-BASE INTERFERENCE REDUCTION FACTORS

154.725 MHz

County No.	Base Location	IRF
11	Storm Lake	.997762
76	Pocahontas	.993123
81	Sac City	.995341
13	Rockwell City	.986777
35	Hampton	.989487
42	Eldora	.987040
61	Winterset	.994900
25	Adel	.987617
48	Marengo	.997831
52	Iowa City	.998192
16	Tipton	.998052
92	Washington	.997533

154.830 MHz

County No.	Base Location	IRF
96	Spencer	.996363
30	Spirit Lake	.999348
32	Esterville	.999487
74	Emmetsburg	.995829
28	Manchester	.987108
31	Dubuque	.993026
49	Maquoketa	.983397
64	Marshalltown	.998508
86	Toledo	.979627
43	Logan	.997990
83	Harlan	.996374
78	Council Bluffs	.996936
70	Muscatine	.969865
58	Wapello	.981037
59	Chariton	.990120
68	Albia	.989018
93	Corydon	.993763
4	Centerville	.994875

154.845 MHz

County No.	Base Location	IRF
46	Dakota City	.98913
99	Clarion	.98285
94	Fort Dodge	.97338
40	Webster City	.98415[illegible]
33	West Union	.99029[illegible]
10	Independence	.9877[illegible]
23	Clinton	.99069[illegible]
5	Audubon	.98266[illegible]
39	Guthrie Ctr.	.98029[illegible]
15	Atlantic	.98897[illegible]
1	Greenfield	.985871
50	Newton	.97312[illegible]
79	Montezuma	.985450

155.010 MHz

County No.	Base Location	IRF
41	Garner	.989785
55	Algona	.994485
95	Forest City	.995073
3	Waukon	.997808
22	Elkader	.994517
45	Cresco	.992342
96	Decorah	.995948
8	Boone	.985503
85	Nevada	.983399
2	Corning	.995865
88	Creston	.989917
20	Osceola	.974255
87	Bedford	.997510
80	Mt. Ayr	.994642
27	Leon	.980647
62	Oskaloosa	.984245
54	Sigourney	.990370
90	Ottumwa	.993422
51	Fairfield	.994333
26	Bloomfield	.990834
89	Keosauqua	.997007

155.070 MHz

County No.	Base Location	IRF
18	Cherokee	.998025
47	Ida Grove	.996810
67	Onawa	.997992
75	LeMars	.998943
97	Sioux City	1.000000
9	Waverly	.996845
12	Allison	.995916
38	Grundy Ctr.	.985844
7	Waterloo	.998720
19	New Hampton	.997501
77	Des Moines	.997562
82	Davenport	.988865
44	Mt.Pleasant	.992431
29	Burlington	.990659

155.190 MHz

County No.	Base Location	IRF
60	Rock Rapids	.99798[illegible]
72	Sibley	.99069
71	Primghar	.99256
84	Orange City	.99638[illegible]
17	Mason City	.98887[illegible]
34	Charles City	.9902[illegible]
66	Osage	.99570[illegible]
98	Northwood	.99527[illegible]
24	Deunison	.998762
14	Carroll	.98697[illegible]
37	Jefferson	.97995[illegible]
6	Vinton	.991806
57	Cedar Rapids	.998526
53	Anamosa	.994571
65	Glenwood	.992596
69	Red Oak	.985567
36	Sidney	.994362
73	Clarinda	.993716
91	Indianola	.981933
63	Knoxville	.983989
56	Ft. Madison	.993696

Table 4-9

Intermodulation: High -Band - Operations, Information, Tactical, Portable and Point-to-Point Channels. Transmitter and Multicoupler Products.

Third - Order Products

Regional Set - f-MHz	$2f_1 - f$	$2f_2 - f$	$2f_3 - f$	$2f_4 - f$	$2f_5 - f$	$2f_6 - f$
H-1						
154.725	– – –	154.20	154.08	153.975	156.975	157.095
155.250	155.775	– – –	155.13	155.025	156.45	156.57
155.370	156.015	155.49	– – –	155.265	156.33	156.45
155.475	156.225	155.70	155.58	– – –	156.225	156.345
155.850	153.60	154.65	154.89	155.1	– – –	155.97
155.910	153.54	154.59	154.83	155.04	155.79	– – –
H-2						
154.830	– – –	154.35	154.29*	154.185	156.87	156.99
155.310	155.79	– – –	155.25	155.145	156.39	156.51
155.370	155.91	155.43	– – –	155.265	156.33	156.45
155.475	156.12	155.64	155.58	– – –	156.225	156.345
155.850	153.81	154.77	154.89	155.1	– – –	155.97
155.910	153.75	154.71	154.83	155.04	155.79	– – –
H-3						
154.845	– – –	154.17	154.32	154.215	156.855	156.975
155.520	156.195	– – –	155.67	155.565	156.18	156.300
155.370	155.895	155.22	– – –	155.265	156.33	156.45
155.475	156.105	155.43	155.58	– – –	156.225	156.345
155.850	153.84	155.19	154.89	155.1	– – –	155.97
155.910	153.78	155.13	154.83	155.04	155.79	– – –
H-4						
155.010	– – –	154.485	154.65	154.545	156.69	156.81
155.535	156.06	– – –	155.70	155.595	156.165	156.285
155.370	155.73	155.205	– – –	155.265	156.33	156.45
155.475	155.94	155.415	155.58	– – –	156.225	156.345
155.850	154.17	155.22	154.89	155.1	– – –	155.97
155.910	154.11	155.16	154.83	155.04	155.79	– – –
H-5						
155.070	– – –	154.56	154.77	154.665	156.63	156.75
155.580	156.09	– – –	155.79	155.685	156.12	156.24
155.370	155.67	155.16	– – –	155.265	156.33	156.45
155.475	155.88	155.37	155.58	– – –	156.225	156.34
155.850	154.29	155.31	154.89	155.10	– – –	155.97
155.910	154.23	155.25	154.83	155.04	155.79	– – –
H-6						
155.190	– – –	154.77	155.01	154.905	156.51	156.63
155.610	156.03	– – –	155.85	155.745	156.09	156.21
155.370	155.55	155.13	– – –	155.265	156.33	156.45
155.475	155.76	155.34	155.58	– – –	155.225	156.345
155.850	154.53	155.37	154.89	155.10	– – –	155.97
155.910	154.47	155.31	154.83	155.04	155.79	– – –

*Note: Underlined 3rd order products have possible interference with fire frequencies

TABLE 4-10 INTERMODULATION INTERFERENCE POSSIBILITIES

4-10A FIRE FREQUENCY

Fire Freq. MHz	LEA Transmitter Final IM Product MHz	Place	Region
154.355	154.35	Delaware County	12
154.190	154.185	Sabula	12
154.160	154.17	Belmond	8
--	--	Oelwein	11
--	--	Wright County	8
154.28	154.29	Colfax	15
154.28	154.29	Delaware County and City	12
154.28	154.29	Dubuque County and City	12
154.28	154.29	Dyersville	12
154.28	154.29	Dysart	15
154.28	154.29	Epworth	12
154.28	154.29	Maquoketa	12
154.28	154.29	Marshall County	15
154.28	154.29	Morning Sun	25
154.28	154.29	Spencer	2
154.28	154.29	Wapello County	25

(m+1) f1 = mf2

order = 2n + 1

IM = Intermod Product frequency (MHz) falling with ± 15 KHz of receiver passband from IM frequency.

Region 1

Order	f1 MHz	f2 MHz	IM MHz
3	155.19	155.610	154.770
3	155.640	155.790	155.475
3	155.640	155.475	155.790
3	155.640	155.370	155.910
7	154.650	154.770	154.280
7	155.190	155.370	154.650
7	155.640	155.790	155.190
7	155.370	155.190	155.910

Region 2

Order	f1 MHz	f2 MHz	IM MHz
3	155.770	155.310	154.235
3	154.830	155.370	154.280
3	154.830	154.280	155.370
3	155.640	155.790	155.475
3	155.475	155.310	155.790
3	155.310	154.830	155.790
3	155.640	155.475	155.790
3	155.370	154.830	155.910
3	155.640	155.370	155.910
5	155.370	155.640	154.830
5	155.475	155.790	154.830

Region 3

Order	f1 MHz	f2 MHz	IM MHz
3	155.655	155.475	155.850
3	155.685	155.475	155.910
5	155.010	155.370	154.280
5	155.370	155.685	154.755

Region 4

Order	f1 MHz	f2 MHz	IM MHz
3	154.755	155.370	154.130
3	155.370	155.565	155.190
3	155.475	155.565	155.385
3	155.565	155.655	155.475
3	155.370	155.190	155.565
3	155.655	155.700	155.610
3	155.565	155.475	155.655
3	155.685	155.700	155.655
3	155.190	154.665	155.700
3	155.685	155.655	155.700
3	155.370	154.890	155.850
3	155.655	155.475	155.850
3	155.700	155.515	155.850
5	154.755	154.800	154.665
5	155.370	155.685	154.130
5	155.370	155.655	154.800
5	155.565	155.655	155.370
5	155.655	155.685	155.610
5	155.850	155.970	155.610
5	155.475	155.370	155.685
5	155.700	155.565	155.970
7	155.190	155.370	154.665
7	155.370	155.565	154.800
7	155.475	155.700	154.800
7	154.800	154.665	155.190
7	155.655	155.685	155.565
7	155.565	155.475	155.850

Region 5

Order	F1 MHz	f2 MHz	IM MHz
3	155.010	155.565	154.445
3	155.010	155.370	154.665
3	155.475	155.565	155.400
3	155.010	154.445	155.565
3	155.700	155.565	155.850
3	155.370	154.770	155.970
5	155.010	155.370	154.280
5	154.445	154.280	154.770
5	155.475	155.700	155.010
5	155.700	155.565	155.970
5	155.790	155.700	155.970
7	155.370	155.565	154.800
7	155.475	155.700	154.800

Region 6

Order	f1 MHz	f2 MHz	IM MHz
3	155.070	155.850	154.280
3	155.070	155.475	154.665
3	155.070	155.370	154.770
3	155.475	155.580	155.370
3	155.640	155.790	155.475
3	155.640	155.700	155.565
3	155.475	155.370	155.580
3	155.640	155.473	155.790
3	155.850	155.910	155.790
3	155.010	154.280	155.850
3	155.010	154.220	155.910
5	155.070	155.475	154.250
5	155.325	155.850	154.280
5	154.650	154.770	154.400
5	155.370	155.850	154.400
5	155.640	155.790	155.325
7	154.650	154.770	154.260
7	154.770	154.665	155.070
7	155.370	155.475	155.070
7	155.475	155.370	155.790
7	154.650	154.250	155.850
7	155.580	155.475	155.910

TABLE 4-10B page 2 PUBLIC SAFETY FREQUENCIES CONT.

Region 7

Order	f1 MHz	f2 MHz	IM MHz
3	155.475	155.640	155.325
3	154.770	154.175	155.370
3	155.640	155.790	155.475
3	155.250	154.725	155.790
3	155.640	155.475	155.790
3	155.640	155.370	155.910
5	155.370	155.910	154.280
5	155.475	155.850	154.725
5	154.650	154.355	155.250
5	155.640	155.790	155.325
7	154.650	154.770	154.280
7	155.475	155.370	155.790

Region 8

Order	f1 MHz	f2 MHz	IM MHz
3	154.845	155.520	154.160
3	155.370	155.910	154.845
3	155.520	155.685	155.370
3	154.845	154.160	155.520
3	154.890	154.250	155.520
3	155.370	154.945	155.910
3	155.685	155.475	155.910
5	155.370	155.910	154.280
7	155.475	155.910	154.160
7	155.270	155.685	154.430
7	155.475	155.685	154.845

Region 9

Order	f1 MHz	f2 MHz	IM MHz
3	155.685	155.475	155.910
5	155.370	155.910	154.280
5	154.725	154.355	155.475
5	155.475	155.370	155.685

Region 10

Order	f1 MHz	f2 MHz	IM MHz
3	154.800	155.475	154.130
3	155.070	155.475	154.665
3	155.475	155.370	155.580
3	155.070	154.280	155.850
3	155.700	155.565	155.850
5	155.070	155.475	154.250
5	155.370	155.910	154.280

Region 11

Order	f2 MHz	f2 MHZ	IM MHz
3	154.845	155.520	154.160
3	155.370	155.910	154.845
3	154.845	154.160	155.520
3	155.700	155.565	155.850
3	155.370	154.845	155.910
5	155.370	155.910	154.280
7	155.475	144.910	154.160
7	155.565	155.475	155.850

Region 12

Order	f1 MHz	f2 MHz	IM MHz
3	154.770	155.370	154.175
3	154.830	155.475	154.175
3	154.830	155.475	154.190
3	154.830	155.370	154.280
3	154.830	155.310	154.355
3	154.800	154.770	154.830
3	154.830	154.355	155.310
3	155.475	155.640	155.310
3	154.830	154.280	155.370
3	155.640	155.790	155.475
3	155.310	154.830	155.790
3	155.640	155.475	155.790
3	155.850	155.910	155.790
3	155.370	154.830	155.910
3	155.640	155.370	155.910
5	155.370	155.640	154.830
5	154.830	154.355	155.790
7	154.650	154.770	154.280

Region 13

Order	f1 MHz	f2 MHz	IM MHz
3	155.370	155.565	155.190
3	155.370	155.190	155.565
3	155.700	155.565	155.850
7	155.190	155.370	154.665
7	155.370	155.190	155.910

Region 14

Order	f1 MHz	f2 MHz	IM MHz
3	155.01	155.370	154.650
3	155.640	155.790	155.475
3	155.640	155.370	155.910
5	155.010	155.370	154.280

Region 15

Order	f1 MHz	f2 MHz	IM MHz
3	154.830	155.370	154.280
3	154.770	154.650	154.890
3	154.830	154.280	155.370
3	155.640	155.790	155.475
3	155.310	154.830	155.790
3	155.270	154.930	155.910
3	155.640	155.370	155.910
5	155.370	155.640	154.830
7	154.650	154.770	154.280

TABLE 4-10B page 3 PUBLIC SAFETY FREQUENCIES CONT.

Region 16

Order	f1 MHz	f2 MHz	IM MHz
3	155.190	155.610	154.770
3	154.770	154.650	154.890
3	155.640	155.790	155.475
3	155.640	155.370	155.910
5	154.650	154.770	154.400
7	154.650	154.770	154.280
7	155.190	155.370	154.650
7	155.640	155.790	155.190
7	155.370	155.190	155.910

Region 17

Order	f1 MHz	f2 MHz	IM MHz
3	155.640	155.790	155.475
3	155.370	154.845	155.910
5	155.370	155.640	154.845

Region 18

Order	f1 MHz	f2 MHz	IM MHz
3	155.370	154.830	155.910
5	155.370	155.655	154.600
7	154.890	154.755	155.310
7	155.655	155.685	155.565

Region 19

Order	f1 MHz	f2 MHz	IM MHz
3	155.685.	155.655	155.700
7	155.655	155.685	155.565

Region 20

Order	f1 MHz	f2 MHz	IM MHz
3	155.640	155.790	155.475
3	155.250	154.725	155.790
3	155.640	155.370	155.910
5	155.370	155.910	154.280

Region 21

Order	f1 MHz	f2 MHz	IM MHz
3	155.070	155.370	154.770
3	155.640	155.790	155.475
3	155.070	154.280	155.850
3	155.640	155.355	155.910
3	155.640	155.370	155.910
5	155.070	155.473	154.265
7	155.370	155.475	155.070
7	155.475	155.370	155.790

Region 22

Order	f1 MHz	f2 MHz	IM MHz
3	155.190	155.610	154.770
3	155.640	155.790	155.475
3	155.640	155.370	155.910
7	154.370	154.280	154.650
7	155.190	155.370	154.650
7	155.640	155.790	155.190
7	155.375	155.370	155.790
7	155.370	155.190	155.910

Region 23

Order	f1 MHz	f2 MHz	IM MHz
3	155.770	154.650	154.890
3	155.640	155.790	155.475
3	155.370	154.845	155.910
3	155.640	155.370	155.910
5	155.370	155.910	154.280
5	154.650	154.770	154.415
5	155.370	155.640	154.845
7	154.650	154.770	154.280

Region 24

Order	f1 MHz	f2 MHz	IM MHz
3	154.640	155.790	155.475
3	155.250	154.725	155.730
3	155.700	155.565	155.850
3	155.640	155.370	155.910
5	155.370	155.910	154.280
5	144.475	155.370	155.685
7	154.755	154.890	154.340
7	,725154.725	154.370	155.790

Region 25

Order	f1 MHz	f2 MHz	IM MHz
3	154.830	155.370	154.280
3	155.640	155.790	155.475
3	155.310	154.830	155.790
3	155.370	154.830	155.910
3	155.640	155.370	155.910
7	154.650	154.770	154.280

Region 26

Order	f1 MHz	f2 MHz	IM MHz
3	155.070	155.370	154.770
3	155.640	155.790	155.475
3	155.640	155.370	155.910

Region 27

Order	f1 MHz	f2 MHz	IM MHz
3	155.010	155.370	154.650
3	154.770	154.650	154.890
3	155.640	155.790	155.475
3	155.640	155.370	155.910
5	154.770	154.650	155.010

Region 28

Order	f1 MHz	f2 MHz	IM MHz
3	155.790	155.640	155.475
3	155.310	154.830	155.790
3	155.370	154.830	155.910
5	155.640	155.790	155.325

Region 29

Order	f1 MHz	f2 MHz	IM MHz
3	155.010	155.370	154.665
3	155.700	155.565	155.850

Region 30

Order	f1 MHz	f2 MHz	IM MHZ
3	155.070	155.475	154.665
3	155.070	154.280	155.850
3	155.700	155.565	155.850

Region 31

Order	f1 MHz	f2 MHz	IM MHz
3	155.370	155.565	155.190
3	155.370	155.190	155.565
3	155.700	155.565	155.850
7	155.190	155.370	154.665
7	155.370	155.190	155.910

Region 32

Order	f1 MHz	f2 MHz	IM MHz
5	155.190	155.610	154.340
5	155.655	155,685	155,610
7	155.190	155.475	154.340
7	155.370	155.190	155.910

TABLE 4-10 C RECEIVER RESPONSES

Region	Received Signal Frequency MHz	Receiver Frequency MHz	Manufacturer
1	155.790	155.370	G. E.
	155.790	154.280	Motorola
2	155.790	154.280	Motorola
3	155.385	155.010	G. E.
	155.370	155.010	G. E.
	155.910	155.535	G. E.
4	155.685	154.130	Motorola
	155.190	154.800	G. E.
5	155.400	155.010	G. E.
	155.370	155.010	G. E.
	155.010	154.665	G. E.
	155.790	155.400	G. E.
6	155.790	155.370	G. E.
	155.475	155.070	G. E.
	155.910	154.400	Motorola
	155.790	154.280	Motorola
	155.790	154.250	Motorola
	155.700	155.325	G. E.
7	155.640	155.250	G. E.
	155.790	155.370	G. E.
	155.790	154.280	Motorola
	155.790	155.385	G. E.
8	155.910	155.520	G. E.
	155.685	155.325	G. E.
	155.685	154.160	Motorola
9	155.655	155.250	G. E.
	155.250	154.890	G. E.
10	155.700	155.325	G. E.
	155.475	155.070	G. E.
11	155.700	155.325	G. E.
	155.700	154.160	Motorola
	155.910	155.520	G. E.
12	155.790	155.370	G. E.
	155.790	154.280	Motorola
	155.700	155.310	G. E.
	155.700	154.175	Motorola
13	155.565	155.190	G. E.
	155.190	154.800	G. E.
14	155.355	155.010	G. E.
	155.370	155.010	G. E.
	155.790	154.280	Motorola
	155.790	155.370	G. E.
	155.910	155.535	G. E.
	155.910	154.400	Motorola
15	155.790	155.400	G. E.
	155.790	154.280	Motorola
	155.910	154.385	Motorola
	155.655	155.310	G. E.
	155.685	155.310	G. E.
	155.790	155.370	G. E.
16	155.790	155.385	G. E.
	155.790	154.280	Motorola
	155.790	155.370	G. E.
	155.910	154.400	Motorola
17	155.790	155.370	G. E.
	155.910	155.520	G. E.
	155.790	155.400	G. E.
	155.790	154.280	Motorola
18	155.655	155.310	G. E.
	155.685	155.310	G. E.
	155.700	155.310	G. E.
19	155.910	155.520	G. E.
20	155.790	154.280	Motorola
	155.640	155.520	G. E.
	155.790	155.370	G. E.
21	155.790	154.280	Motorola
	155.790	154.265	Motorola
	154.650	155.370	G. E.
	155.475	155.070	G. E.
22	155.790	154.280	Motorola
	155.790	155.370	G. E.
23	155.790	155.385	G. E.
	155.790	154.280	Motorola
	155.790	155.370	G. E.
	155.910	155.520	Motorola
	155.910	154.415	G. E.
24	155.640	155.250	G. E.
	155.790	155.385	G. E.
	155.790	154.280	Motorola
	155.790	155.370	G. E.
	155.655	155.250	G. E.
	155.250	154.890	G. E.
	155.910	154.415	Motorola
25	155.790	155.400	G. E.
	155.790	154.250	Motorola
	155.790	154.280	Motorola
	155.790	155.370	G. E.
	155.700	154.145	Motorola
	155.700	155.310	G. E.
26	155.790	155.400	G. E.
	155.790	154.280	Motorola
	155.790	155.370	G. E.
	155.400	155.070	G. E.
	155.475	155.070	G. E.
27	155.790	155.400	G. E.
	155.790	155.370	G. E.
	155.400	155.010	G. E.
	155.370	155.010	G. E.
	155.910	155.535	G. E.
28	155.700	155.325	G. E.
	155.700	155.310	G. E.
	155.790	155.370	G. E.
29	155.700	155.325	G. E.
	155.010	154.665	G. E.
	155.370	155.010	G. E.
	155.910	155.535	G. E.
30	155.475	155.070	G. E.
	155.910	154.400	Motorola
31	155.565	155.190	G. E.
	155.190	154.800	G. E.
32	None		

Table 4-11 UHF FREQUENCY PLAN - CITY BASE TRANSMIT

City	Code	Frequency - MHz						
Ames	167.9	460.200						
Ankeny	(203.5)	(460.275)						
Bettendorf	(156.8)	460.375						
Burlington	146.2	(460.075)						
Carter Lake	167.9	(460.325)						
Cedar Falls	141.3	460.225						
Cedar Rapids/Marion	192.8	460.175	460.250	460.300	460.400	460.475		
Clinton	146.2	460.200						
Council Bluffs	169.2	460.050	460.325	460.400				
Davenport (6)	(156.7)	(460.125)	(460.150)					
Des Moines (6)	(203.5)	(460.025)	(460.150)	(460.225)	(460.325)	460.350*	(460.400)	(460.500)
Dubuque	192.8	460.375	460.450					
Ft. Dodge	146.2	460.125						
Iowa City	146.2	460.050	460.100					
Marshalltown	146.2	460.325*						
Mason City (7)	146.2	(460.375)						
Muscatine	127.3	460.175						
Omaha (3)	127.3	(460.100)	(460.150)	(460.225)	(460.275)	(460.375)	(460.425)	(460.500)
Ottumwa (6)	(107.2)	(460.375)						
Sioux City (8)	146.2	<u>460.075</u>	<u>460.175</u>	<u>460.300</u>	<u>460.400</u>			
Waterloo (6)	(141.3)	(460.025)	(460.050)	(460.100)				
West Des Moines/Urbandale	(203.5)	460.075	460.450					

1. Frequencies presently in use are shown in parenthesis as : (Des Moines).
2. Those frequencies requested by application are underlined.
3. Frequencies used by Omaha are shown because of their impact on Iowa planning.
4. *Recommended that Des Moines change from present use of 460.325 to 460.350 MHz to correct intermod product in present frequency usage.
5. A corresponding 465.XXX MHz frequency is associated with each 460.XXX MHz used for base transmissions.
6. Some presently used CTCS frequencies are "A" group frequencies.
7. Tone code presently used is 127.3 MHz also used by Omaha and should be changed to 146.2 as shown
8. Sioux City and Council Bluffs are each assigned this frequency. On occasion there may be duct propagation which causes interference from base-to-mobile or from mobile-to-base. It is recommended that these frequencies be used by each more for mobile-mobile/portable communications.

TABLE 4-12

UHF TRANSMITTER FINAL STAGE IM PRODUCTS

Des Moines

f-MHz	$2f_1$-f	$2f_2$-f	$2f_3$-f	$2f_4$-f	$2f_5$-f	$2f_6$-f
460.025	- - -	459.95	459.825	459.70	459.65	459.55
460.150	460.275	- - -	460.075	459.95	459.9	459.8
460.225	460.425	460.3	- - -	460.10	460.05	459.95
460.350	460.675	460.55	460.475	- - -	460.3	460.2
460.400	460.775	460.65	460.575	460.45	- - -	460.3
460.500	460.975	460.85	460.775	460.65	460.6	- - -

Note: (1) The following line indicates a problem in the Des Moines frequency usage causing an intermod problem on two other channels.

460.325	460.625	460.5	460.425	- - -	460.25	460.15

(2) West Des Moines and Urbandale transmitting sites are sufficiently removed to avoid IM produced in final transmitter stages.

Cedar Rapids/Marion

f-MHz	$2f_1$-f	$2f_2$-f	$2f_3$-f	$2f_4$-f	$2f_5$-f	$2f_6$-f
460.175	- - -	460.1	460.05	459.875	459.95	
460.250	460.325	- - -	460.20	460.025	460.10	
460.300	460.425	460.35	- - -	460.125	460.20	
460.475	460.775	460.70	460.65	- - -	460.55	
460.400	460.625	460.55	460.5	460.325	- - -	

Sioux City

f-MHz	$2f_1$-f	$2f_2$-f	$2f_3$-f	$2f_4$-f
460.075	- - -	459.975	459.85	459.75
460.175	460.275	- - -	460.05	459.95
460.300	460.525	460.425	- - -	460.2
460.400	460.725	460.625	460.5	- - -

Council Bluffs/Carter Lake

f-MHz	$2f_1$-f	$2f_2$-f	$2f_3$-f	Omaha Produced 3rd Order IM (X)
460.050	- - -	459.775	459.7	X
460.325	460.60	- - -	460.25	X
460.400	460.75	460.475	- - -	

Note: No IM produced by Council Bluffs on Omaha frequencies.

Dubuque

f	$2f_1$-f	$2f_2$-f
460.375	- - -	460.3
460.450	460.525	- - -

Iowa City

f	$2f_1$f	$2f_2$-f
460.050	- - -	460.00
460.100	460.15	- - -

TABLE 4-13 CTCSS FREQUENCIES

TABLE 4-13A SYMBOL AND FREQUENCY LISTING

Code Symbol	Frequency, Hz
A	127.3
B	146.2
C	167.9
D	192.8

TABLE 4-13B IOWA HIGHWAY PATROL RADIO USAGE AREA / TONE / FREQUENCY

* Base/Repeater	Area Freq. Plan	CTCS Tone
Storm Lake	P1	A
Matlock		C
Merrill		B
Terril		D
Belmond	P2	A
Blairsburg		B
Cedar Falls	P3	B
Lourdes		C
Watson		D
Delaware/Buchanan (probable added repeater)		A
Maquoketa	P1	C
Watson		D
Muscatine		A
Fairfield	P3	C
Burlington		A
Albia		B
Cedar Rapids	P2	C
Kent Church		D
Des Moines	P1	B
Van Wert		A
Denison	P3	A
Moorhead		B
Guthrie Center		D
Lewis	P2	B
New Market		A
Glenwood		D

* Refer to Figure 4-1 for location and county assignments for these area frequencies.

TABLE 4-13C SELECTIVE CALLING TONE CODE FREQUENCIES

Tone Code No.	Nominal Tone Code Frequency	Tone Code No.	Nominal Tone Code Frequency
1	450.0 Hz	11	805.9 Hz
2	477.0	12	854.2
3	505.6	13	905.5
4	536.0	14	959.8
5	568.1	15	1017.4
6	602.2	16	1078.5
7	638.3	17	1143.2
8	676.6	18	1211.7
9	717.2		
10	760.3		

TABLE 4-14 CITIES – POPULATION OVER 20,000 – UHF SYSTEMS

Number Channels UHF Pairs	Municipality	Generic Type	Antenna Location	Lat.	Long.	Tower Base MSL	Tower Height Feet	Rad. Center of Antenna Feet	Ant. Type Spec. Id.	Transmitter Power Out-Put Watts	Number of Rx's	Remarks **
1	Ames	2C or D	PD	420152	933648	925	200	210	D-2	25	1	T1
1	Bettendorf	3B or C	High School	433145	903010	600	150	160	D-2	25	1	T1
1	Burlington	3C	Existing Site	404910	910751	698	150	160	D-2	25	2	T1
1	Cedar Falls	3B or C	PD	423212	922653	870	160	170	D-2	25	1	T1
1	Clinton	3C	Mt. Pleasant Park	415057	901215	700	110	120	D-2	25	1	T1
1	Fort Dodge	3C	Water tower	423026	940958	1113	130	140	D-2	25	1	T1
2	Iowa City (2 Chan)	3C	New Site	414015	913136	760	150	160	D-2	25	2	T1, T2
1	Mason City		Existing Site	430822	931200	1169	135	140	Existing	25	1	180 Watts authorized
1	Marshalltown	3C	Existing Site	420255	925447	935	150	160	D-2	25	1	T1
1	Muscatine	3C	Old Fire Station Existing Site	412508	910315	720	100	110	D-2	25	1	T1
1	Ottumwa		Existing	410104	922445	829	200	200	Existing			
3	Council Bluffs	3A	Memorial Park Cem. W.T.	411549	954929	1242	150	160	D-3	(qty2)25	2	T1, T2
			New Site Fairmont Park	411515	955043	1270	120	130	D-2	(qty1)25	1	T3
2	Davenport		Existing									
6	Des Moines		Existing									
3+1	Sioux City	3A	New Site North W.T.	423237	962336	1410	200	220	D-2 + D-3	(qty 3)100	3	Main remote base .1,T2,T3
			PD	422948	962445	1105	80	90	D-2	(qty 1) 25	3	Backup Base @PD T1/2
			Riverside	423100	962900	1110	80	90	D-2	–	2-3	Rx's only
			Morningside	424842	962020	1325	100	110	D-2	–	2-3	Rx's only
3	Waterloo	3A*	New Site East W.T.	423006	921900	870	150	160	D-3	(qty2)25	3	T1, T2
		(Existing)	New Site W.T. @ CEM	422832	922126	950	120	130	D-2	(qty1)25	3	T3
			W.W'loo W.T. on 218	423002	922213	925	100	110	D-2	–	3	
5	Cedar Rapids	3A	New Site Mt.Vernon Rd/ Memorial Drive	415833	913714	870	120	130	D-3	(qty2)25	5	Remote Base #1, T1 & T2
			New Site Glass Rd WT	420052	914045	920	120	130	D-3	(qty2)25	5	Remote Base #2, T3 & T4
			New Site Thomas Park	420136	913647	890	100	110	D-2	(qty1)25	5	Remote Base #3, T5
			Comm Engr. Tower	415700	914159	380	200	200	D-2a	–	5	Satellite Rx only
2	Dubuque	3A	City W.T	422954	904109	395	120	130	D-3	(qty2)25	2	T1 and T2
		3C	New Site Satellite	423135	903937	840	80	90	D-2	–	2	
2	W. Des Moines/		City W.T.	413455	934330	930	130	140	D-2	(Qty 1) 25	2	Should have com- T1, T2
	Urbandale (existing)	"	City W.T.	413735	934535	968	100	123	D – 2	Existing(70)	2	bined Comm Center. T1

* Although it is an existing system, the system tabulated is revised to resolve propagation problems.

** Transmit frequencies at each site indicated by T1, T2, etc.
T 1/2 indicates multiple frequency transmitter.

NOTE: Same as Table 2-10, Volume I

TABLE 4-15 REGIONAL SYSTEM SITE LOCATION AND ANTENNA CONFIGURATION

[Refer to Figure 4-1 (page 107) for Regional Map]

REGION 1

Base Station at Sheldon
43° 10' N, 95° 50' W
Tower Height: 300 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8b

REGION 2

Remote Base: New. Centrally located in region, SE of Terrill
43° 15' N, 94° 55' W
Tower Height: 180 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8

REGION 3

Remote Base: New. Centrally located in region, slightly east of Titonka
43° 14' N, 94° 00' W
Tower Height: 180 ft.
Antennas:
High-Band-Specification D-4
Low-Band - Specification D-8

REGION 4

Remote Base: New. Centrally located in region, midway between Osage and Plymouth
43° 15' N, 93° 00' W
Tower Height: 180 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8

REGION 5

Base Station: Decorah
43° 17' 12" N, 91° 50' 42" W
Tower Height: 165 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8

Remote Base at Cresco
43° 21' 00" N, 92° 06' 00" W
Tower Height: 1,100 ft
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-9

Remote Base at Elkader
42°, 52', 00" N, 91°, 22', 00"W
Tower Height: 120 ft.
Antennas:
High-Band - Specification D-4
Low - Band- Specification D-8

REGION 6

Base Station: Sioux City (north water tower site)
42°, 32', 37" N, 96°, 23', 36" W
Tower Height: 200 ft.
Antennas:
High-Band - Specification D-5 (SE)
Low-Band - Specification D-8b (SE)

Remote Base: 1 mile north of Mapleton
42°, 12', 00" N, 95°, 47', 00" W
Tower Height: 150 ft.
Antennas:
High-Band - Specification D-6b (NE)
Low-Band - Similar to D-6b (NE)

Remote Base: New, at Remsen
42°, 46', 00" N, 95°, 57', 00"W
Tower Height: 150 ft.
Antennas:
High-Band - Specification D-6b (E-W)
Low-Band - Similar to D-6a

REGION 7

Remote Base: New. Centrally located near Fonda.
42° 34' 00" N, 94° 53' 00" W
Tower Height: 180 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8

REGION 8

Remote Base: New. Centrally located near Eagle Grove
42° 35' 00" N, 93° 58' 00" W
Tower Height: 180 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8

REGION 9

Base Station: New. Iowa Falls
42° 35' 00" N, 93° 58' 00" W
Tower height: 180 ft
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8

REGION 10

Remote Base: New. Near Waverly
42° 45' 00" N, 92° 32' 00" W
Tower Height: 280 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Similar to Specification D-8b, except omni configuration

REGION 11

Remote Base: New, Near Oelwein
42° 40' N, 91° 55' W
Tower Height: 148 ft.
Antennas:
High-Band - Specification D-6b (N-S)
Low-Band - Similar to specification D-6 (N-S)

REGION 12

Remote Base: New. South central Delaware County near Cascade
42° 20' 06" N, 90° 58' 00" W
Tower Height: 240 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8

REGION 13

Remote Base: New. West of Carroll
42° 01' 00" N, 94° 53' 00" W
(This site will have to be carefully selected for a local prominence and may ultimately be moved slightly further west)
Tower Height: 200 ft.
Antennas:
High-Band - Specification D-6b (E-W)
Low-Band - Similar to Specification D-6a.

REGION 14

Base Station: Ames
42° 01' 52" N, 93° 36' 31" W
Tower Height: 200 ft.
Antennas:
High-Band - Specification D-6b
Low-Band -Similar to Specification D-6a.

REGION 15

Base Station: Marshalltown (present site)
42° 02' 55" N, 92° 54' 47" W
The present site at Marshalltown is non-prominent, requiring some additional tower height.
Tower Height: 200 ft.
Antennas:
High-Band - Specification D-6b
Low - Band- Similar to specification D-6a.

REGION 16

Remote Base: New. Near Linn Coun- Home
42° 05' 35" N, 91° 32' 55" W
Tower Height: 300 ft.
Antennas:
High-Band - Specification D-6b.
Low-Band- Similar to specification D-6a.

REGION 17

Base Station: Clinton (present site)
41° 50' 48" N, 90° 12' 12" W
Tower Height: 300 ft.
Antennas:
High Band -Spec D-7(W) or equivalent
Low-Band -Specification D-8b (W)
(A relatively large tower is required at Clinton to remain at the present location which is non-prominent with respect to the Western terrain)

REGION 18

Base Station: Council Bluffs
41° 15' 41" N, 95° 49' 33" W
Tower Height: 150 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8

Remote Base: new in SW Shelby County (Near Portsmouth)
41° 37' 30" N, 95° 31' 00" W
Tower Height: 120 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8

REGION 19

Remote Base: New. Centrally located in region near Adair
41° 30' N, 94° 42' W
Tower Height: 180 ft.
Antennas:
High-Band - Specification D-4
Low - Band - Specification D-8

REGION 20

Base Station: New. Dallas county near Waukee operated remotely from West Des Moines
41° 35' N, 93° 55' W
Antennas:
High-Band - Specification D-4
Low -Band - Specification D-8

REGION 21

Base Station: Des Moines (present site)
41° 41' 01" N, 93° 35' 36" W
Tower Height: 137 ft.
Antennas:
High-Band - Specification D-4
Low -Band - Specification D-8

REGION 22

Remote Base: New. Western Marion County
41° 20' 40" N, 93° 16' 00" E
Tower Height: 100 ft.
Antennas:
High-Band - Specification D-6(E-W)
Low-Band -Similar to Specification D-6

REGION 23

Remote Base: New. East of Newton
41° 42' 18" N, 92° 50' 00" E
Tower Height: 147 ft.
Antennas:
High-Band - Specification D-7(E-W)
Low -Band - Specification D-6(E-W)

REGION 24

Remote Base: Near Coralville
41° 43' 45" N, 91° 31' 12" W
Tower Height: 300 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Similar to Specification D-8b except in omni configuration

REGION 25

Base Station: Muscatine (present site)
41° 26' 01" N, 91° 05' 01" W
Tower Height: 100 ft.
Antennas:
High-Band - Specification D-4
Low-Band -Specification D-8

REGION 26

Base Station: Davenport
41° 31' 01" N, 90°, 35' 44" W
Tower Height: 180 ft.
Antennas:
High-Band - Specification D-4
Low -Band - Speicfication D-8

REGION 27

Remote Base: New. South of Creston
40° 53' 00" N, 94° 22' 00" W
Tower Height: 250 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Similar to Specification D-8, except omni configuration

REGION 28

Remote Base: New. South of Chariton
40° 53' N, 93° 18' 27" W
Tower Height: 200 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Speicfication D-8

REGION 29

Base Station: Ottumwa (present site
41° 01' 04" N, 92° 24' 45" W
Tower Height: 300 ft.
Antennas:
High-Band - Specification D-4
Low -Band - Specification D-8

REGION 30

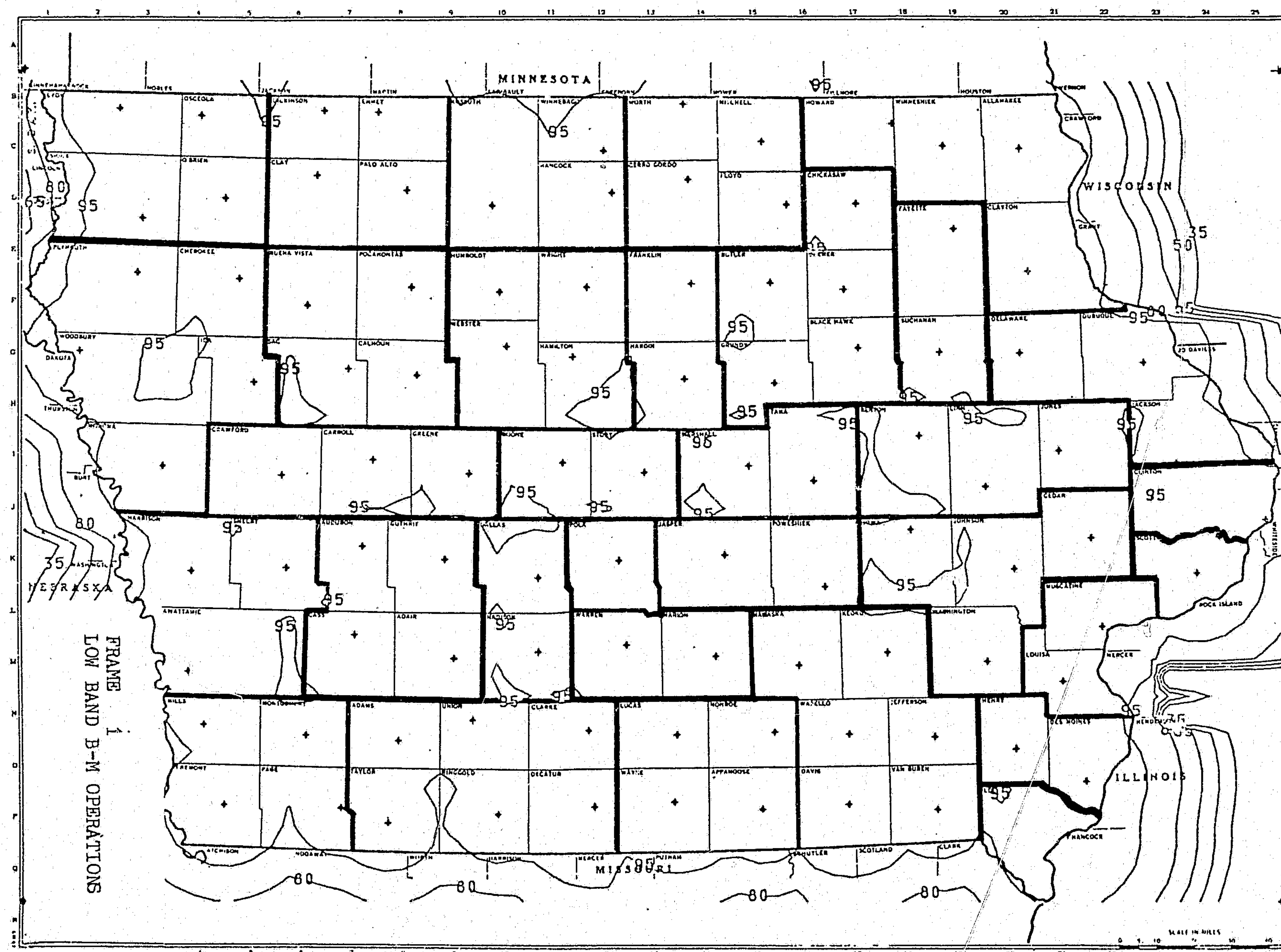
Remote Base: West Burlington
40° 51' 13" N, 91° 18' 00" W
Tower Height: 200 ft.
Antennas:
High-Band - Specification D-4
Low-Band - Specification D-8

REGION 31

Base Station: New. Fort Madison
40° 37' 49" N, 91° 17' 51" W
Tower Height: 80 ft.
Antennas:
High-Band - Specification D-4
Low -Band - Specification D-8

REGION 32

Remote Base: Near centrally located region near Imogene
40° 55' 00" N, 95° 26' 00" W
Tower Height: 120 ft.
Antennas:
High-Band - Specification D-4
Low- Band - Specification D-8



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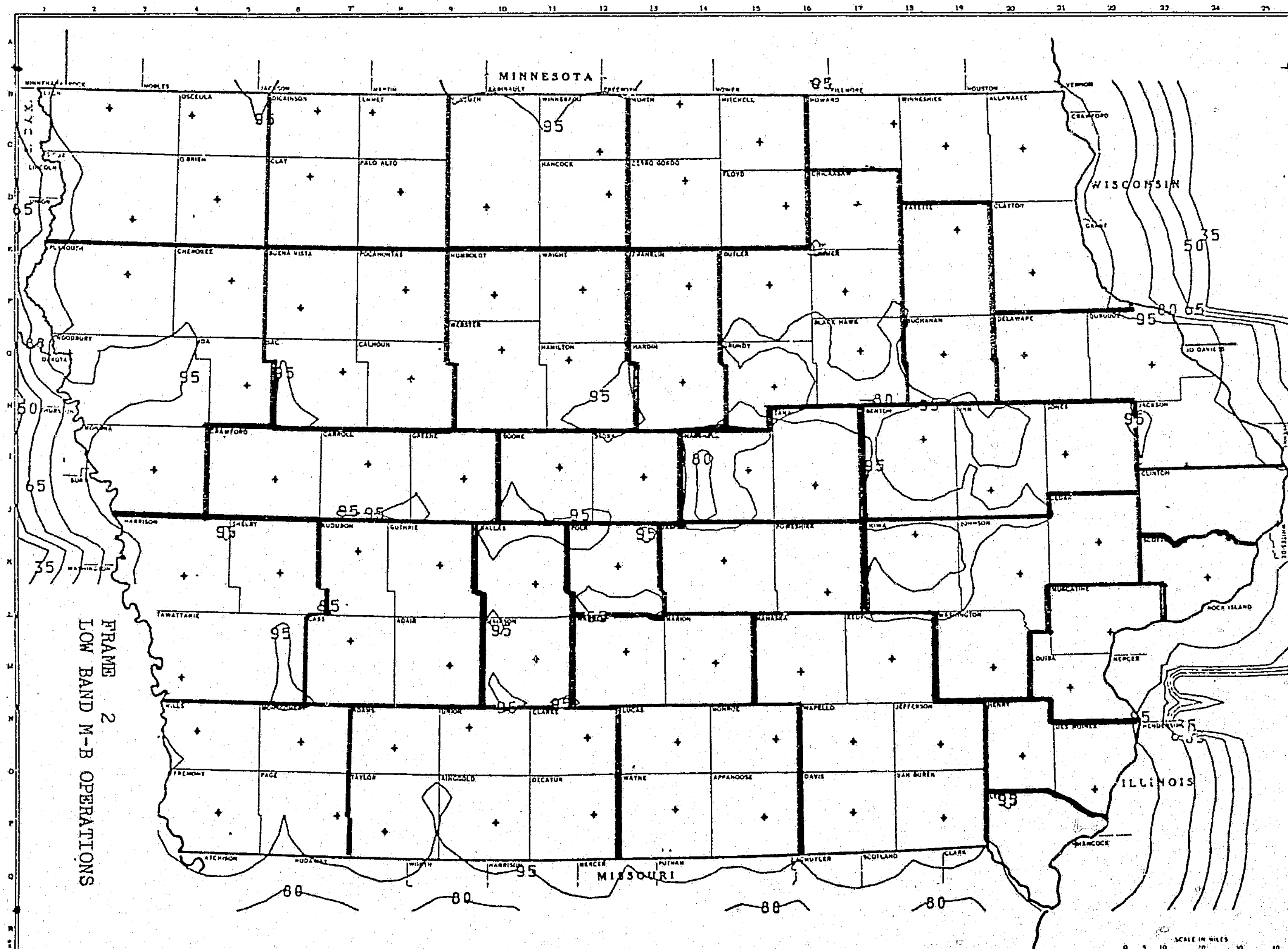
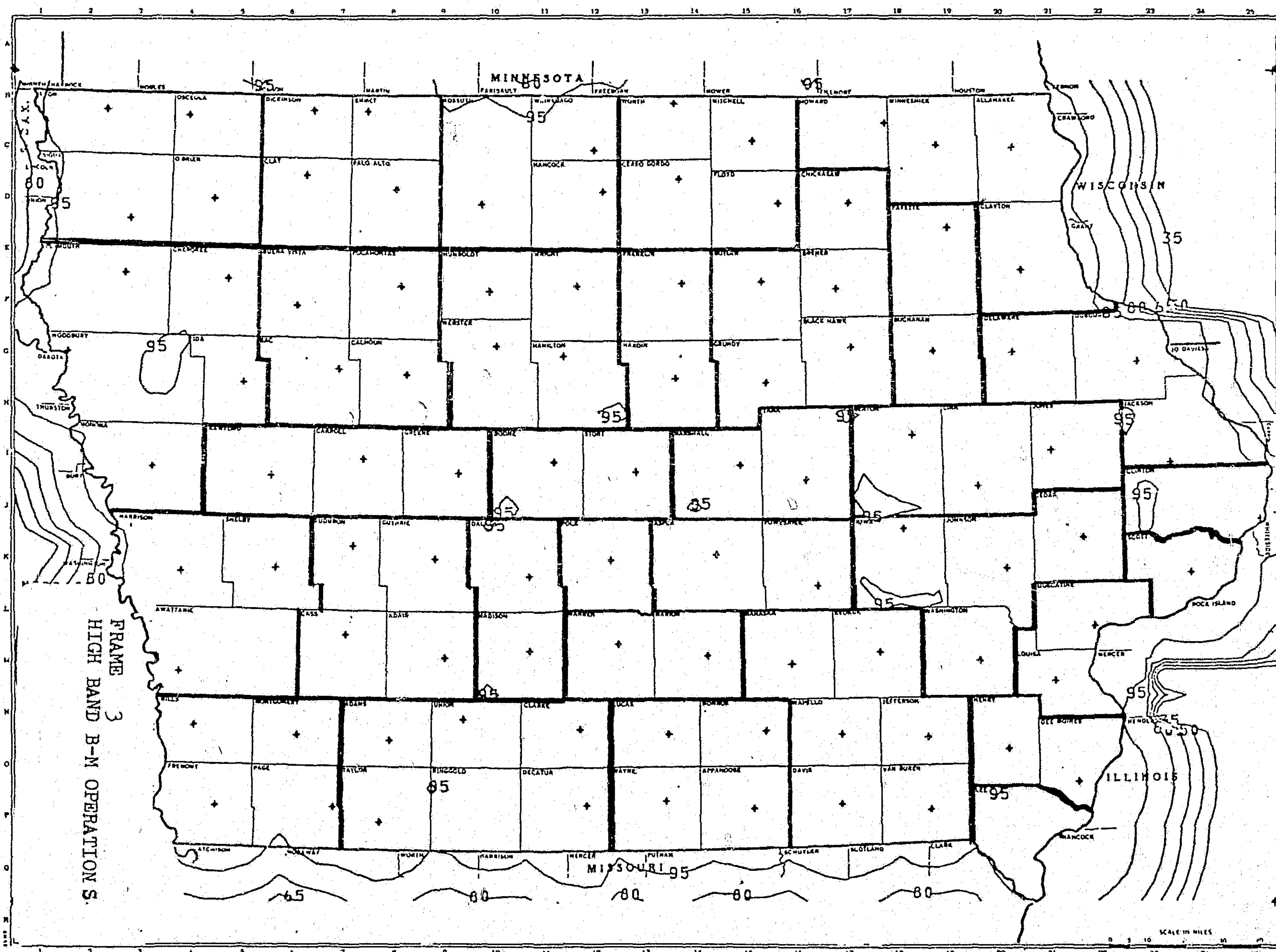
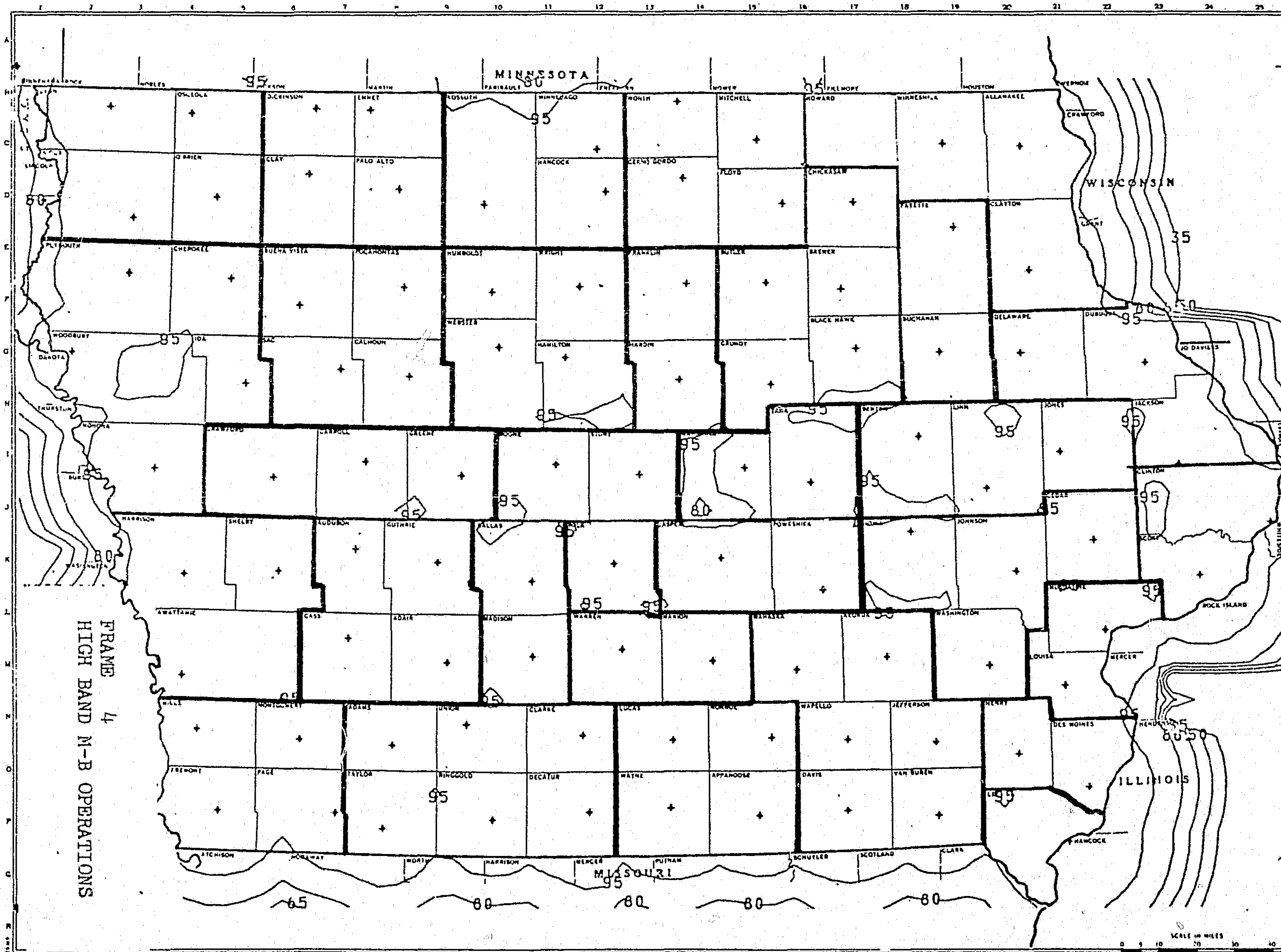
LOW BAND B-M OPERATIONS



FRAME 2
LOW BAND M-B OPERATIONS



FRAME 3
HIGH BAND B-M OPERATION S.



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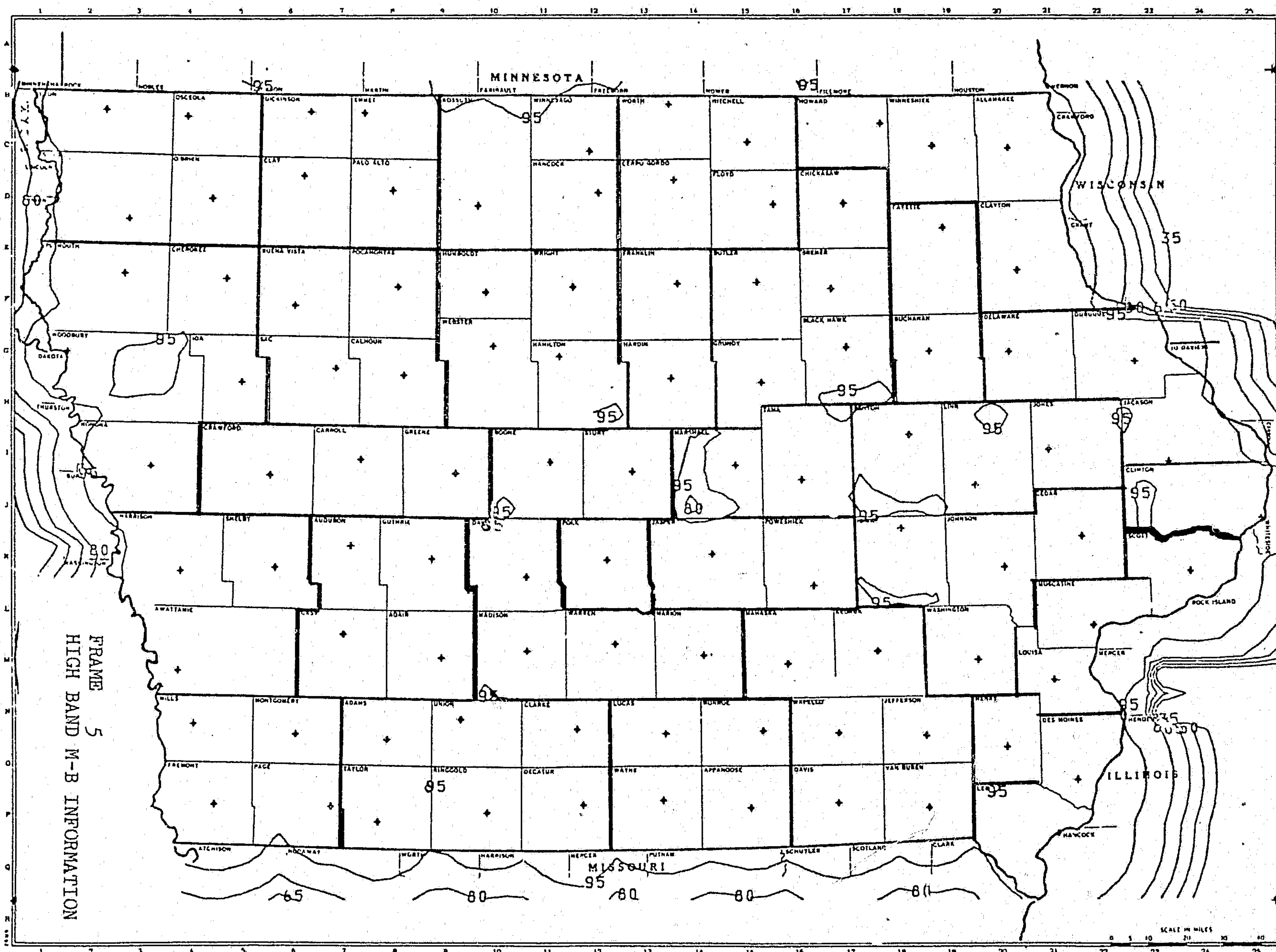
HIGH BAND M-B OPERATIONS



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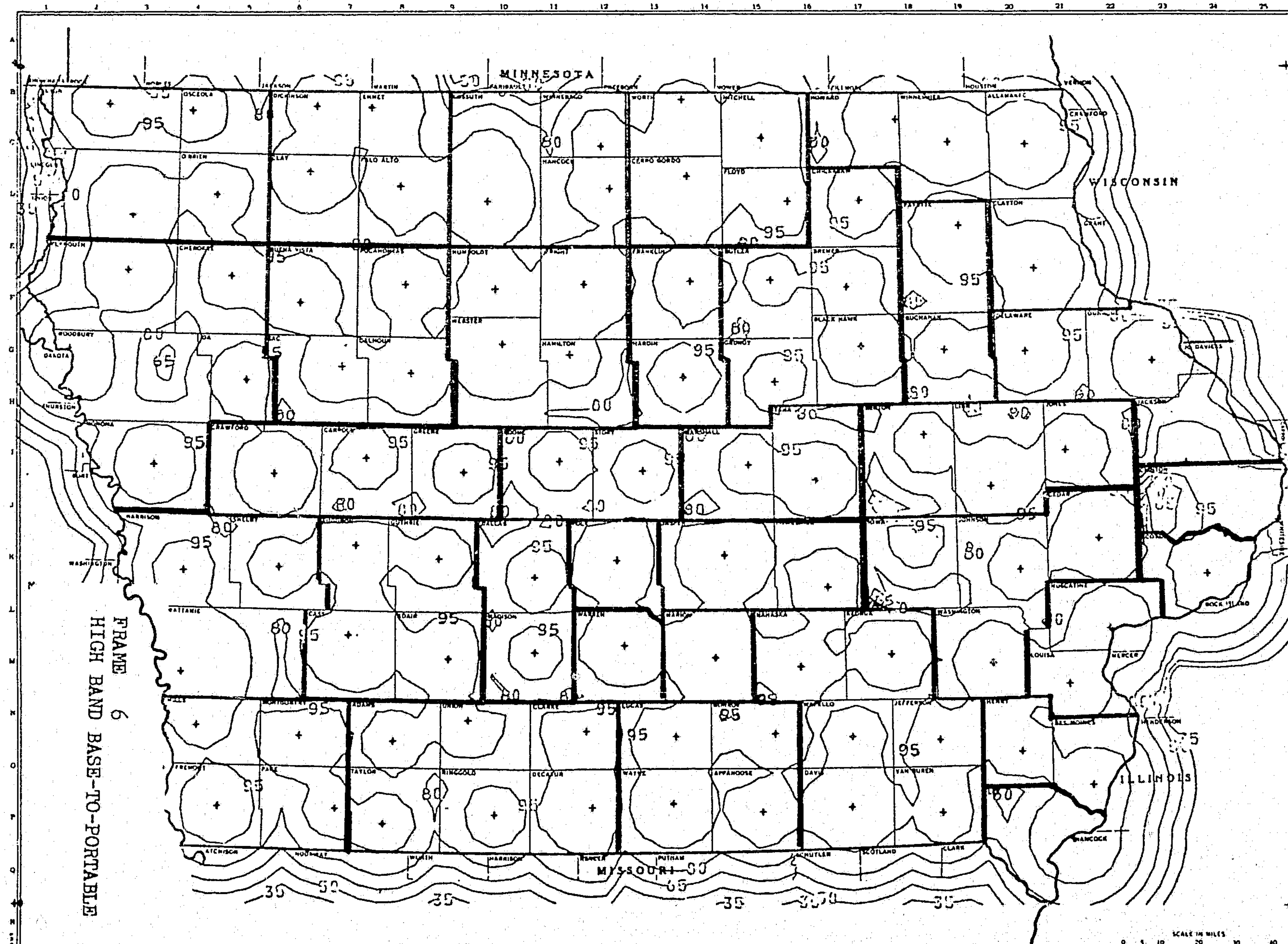
HIGH BAND M-B INFORMATION



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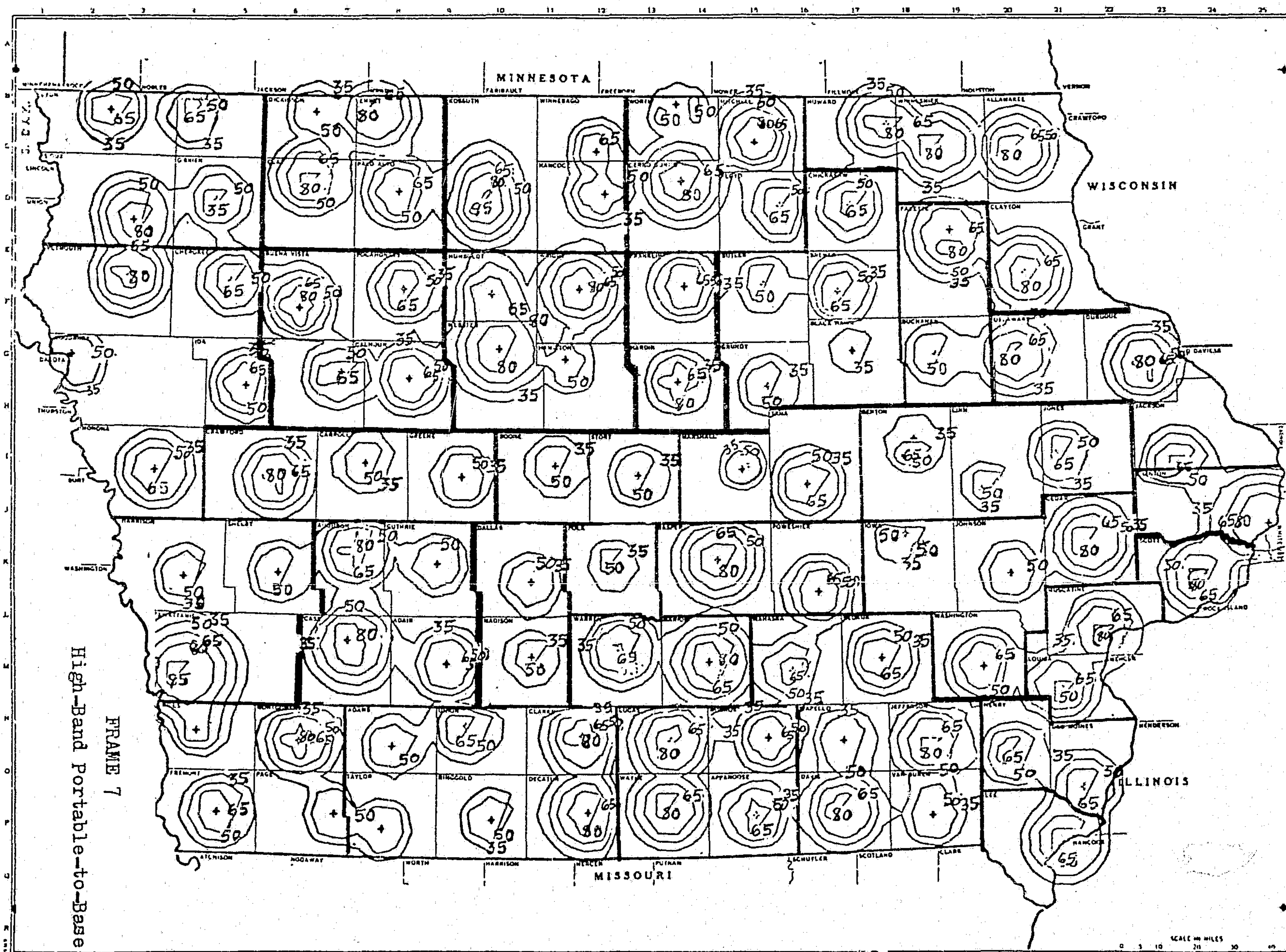

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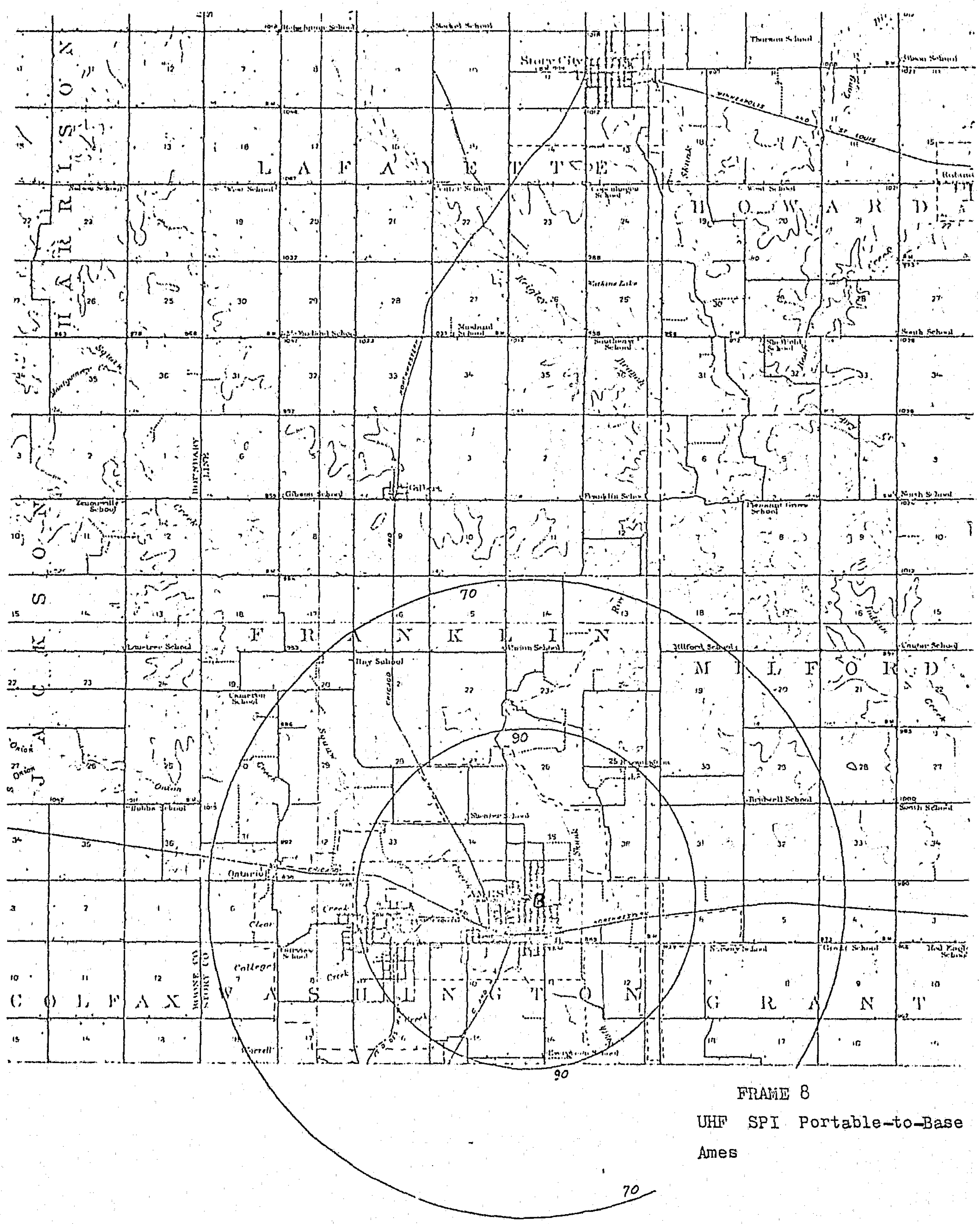
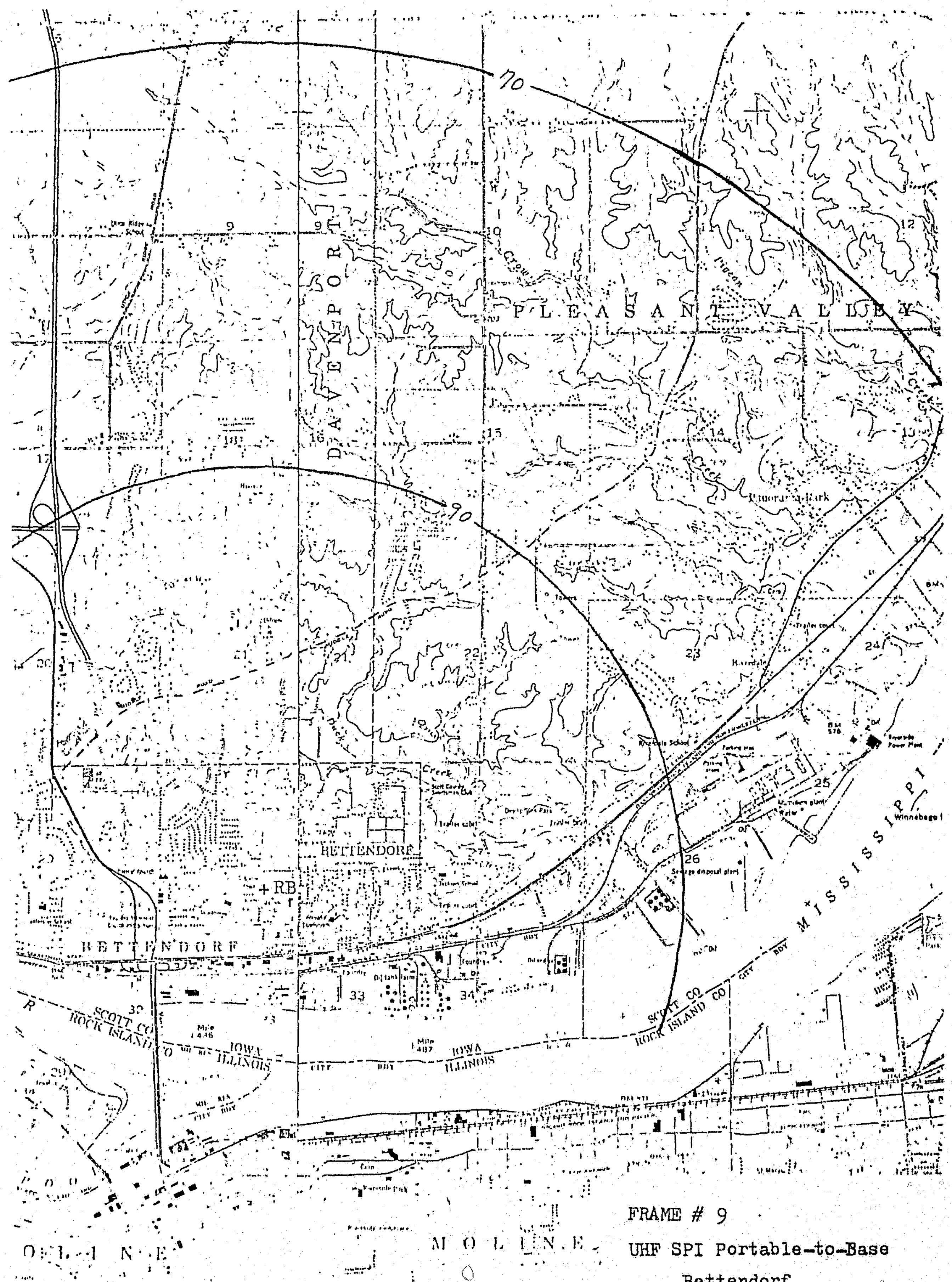


FRAME 8

UHF SPI Portable-to-Base

Ames

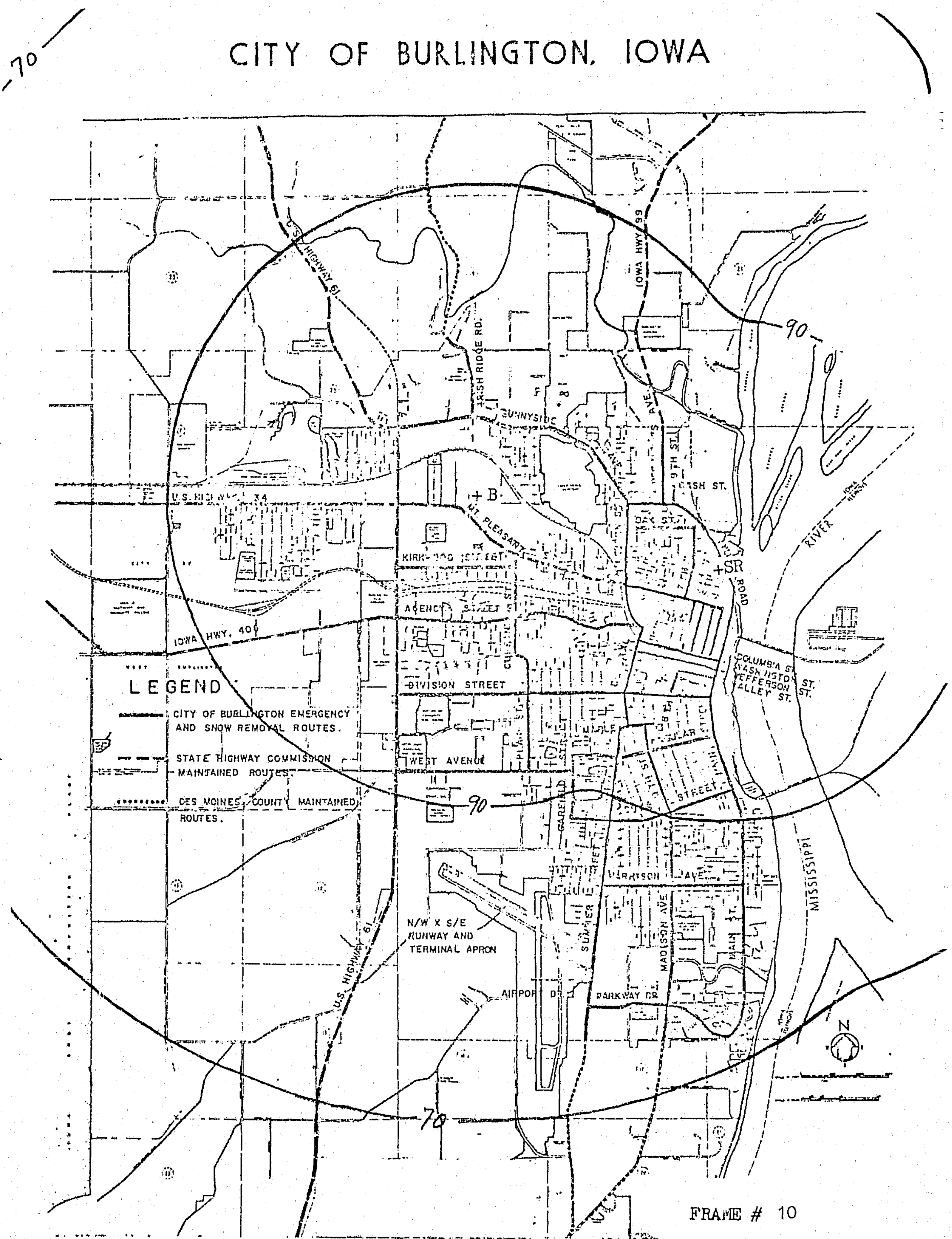


FRAME # 9

UHF SPI Portable-to-Base

Bettendorf

CITY OF BURLINGTON, IOWA



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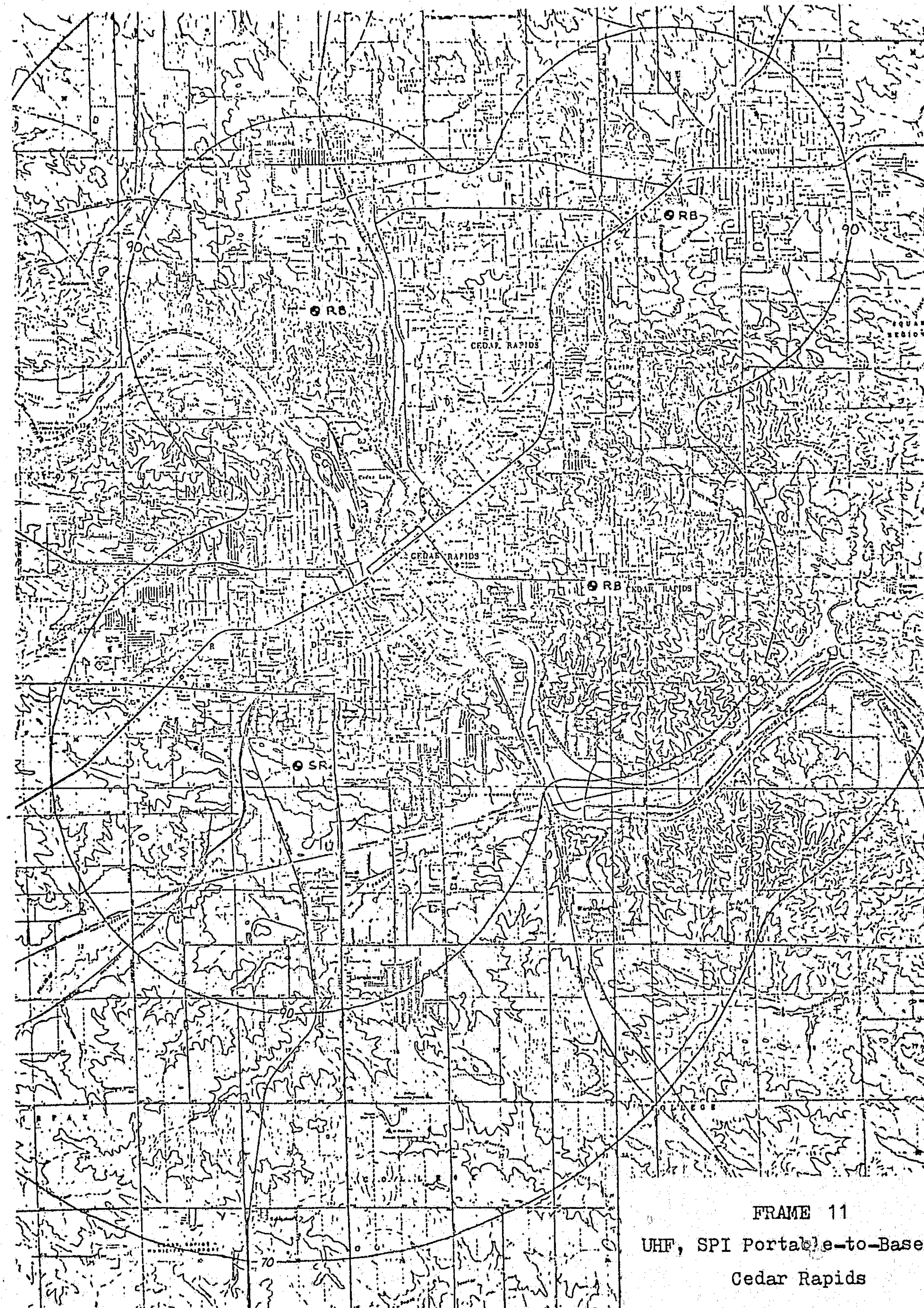
UHF, SPI, Portable-to-B

Burlington



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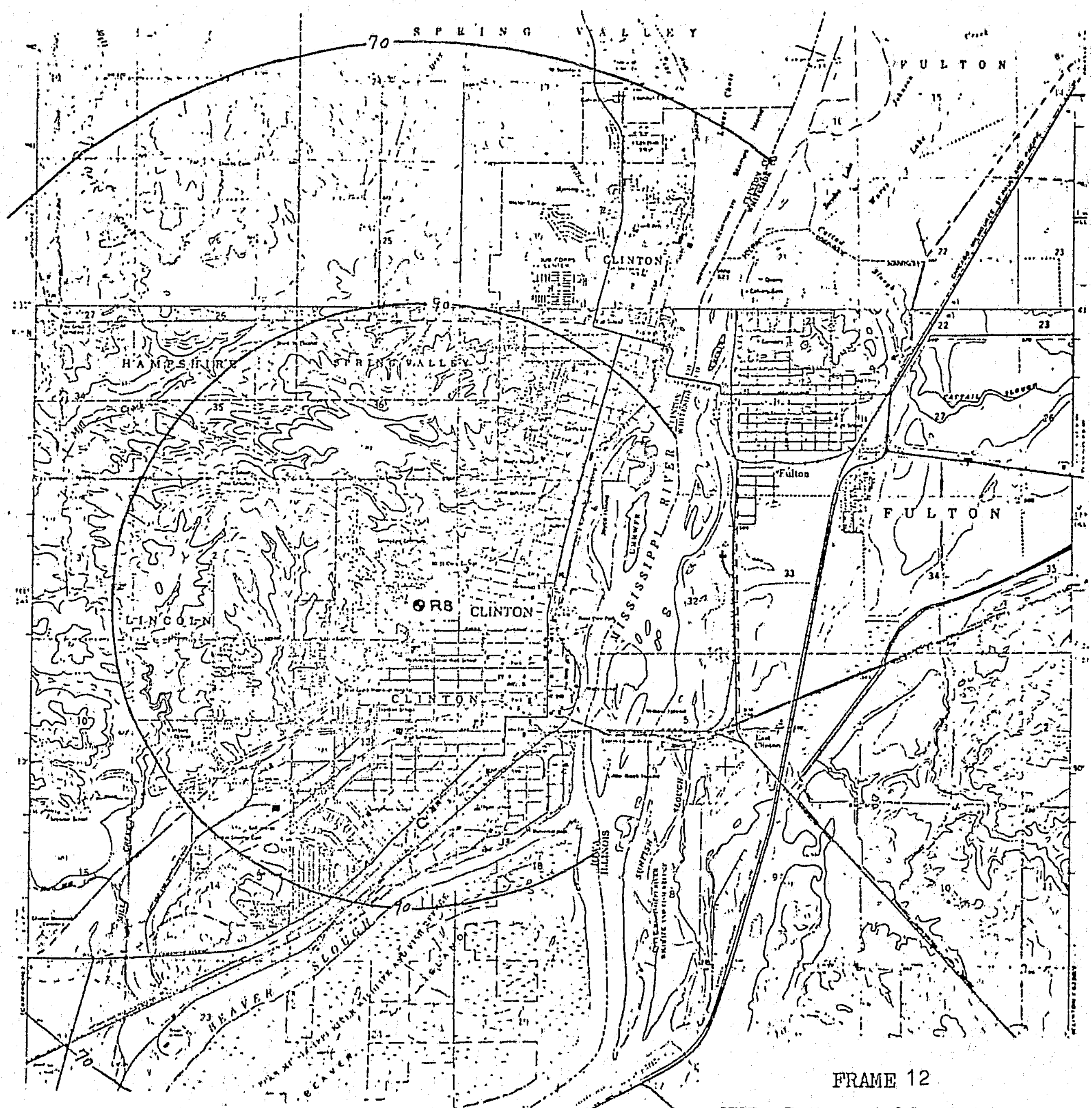
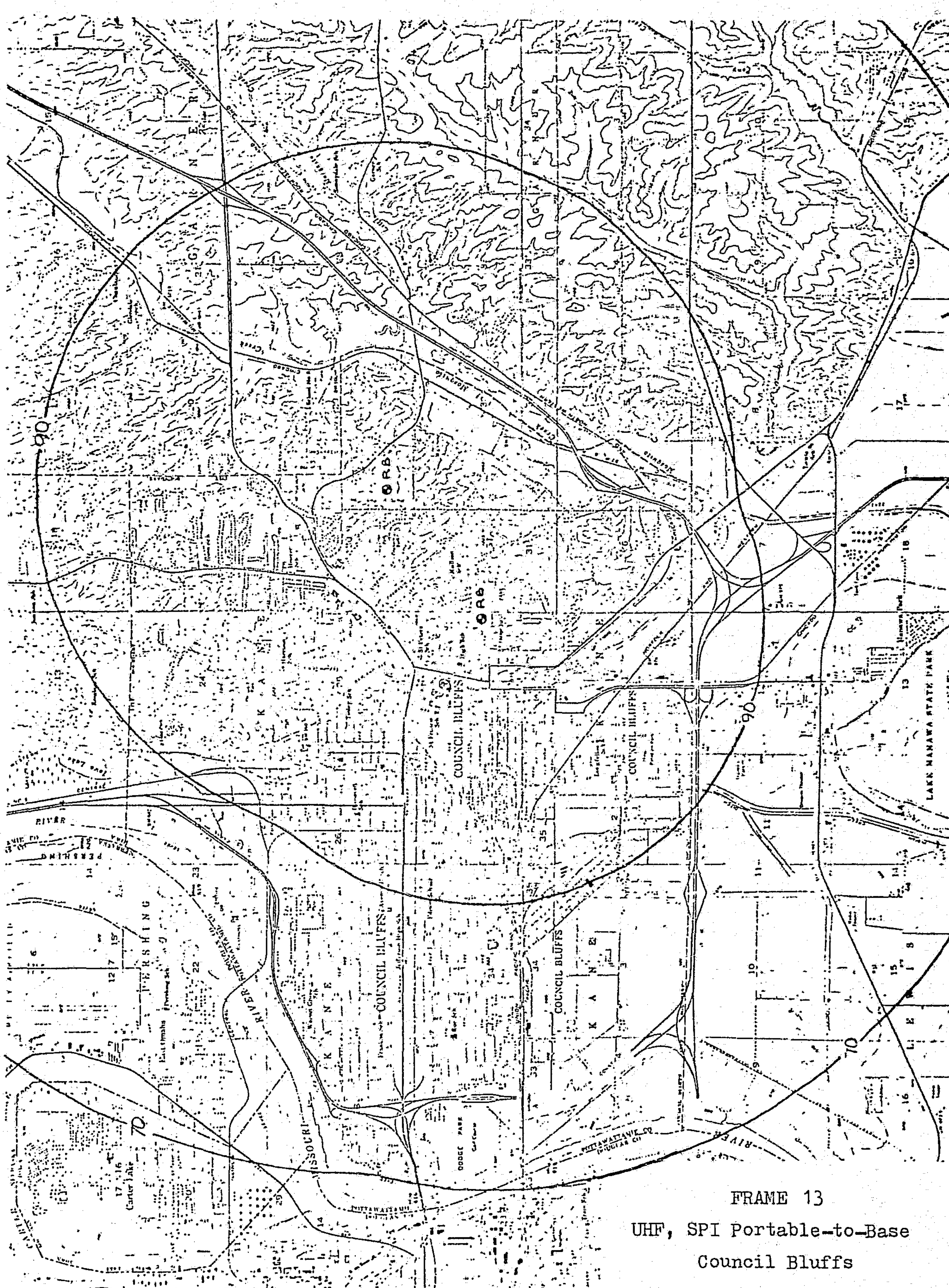
UHF, SPI Portable-to-Base
Cedar Rapids



FRAME 12

UHF, SPI Portable-to-Base

Clinton

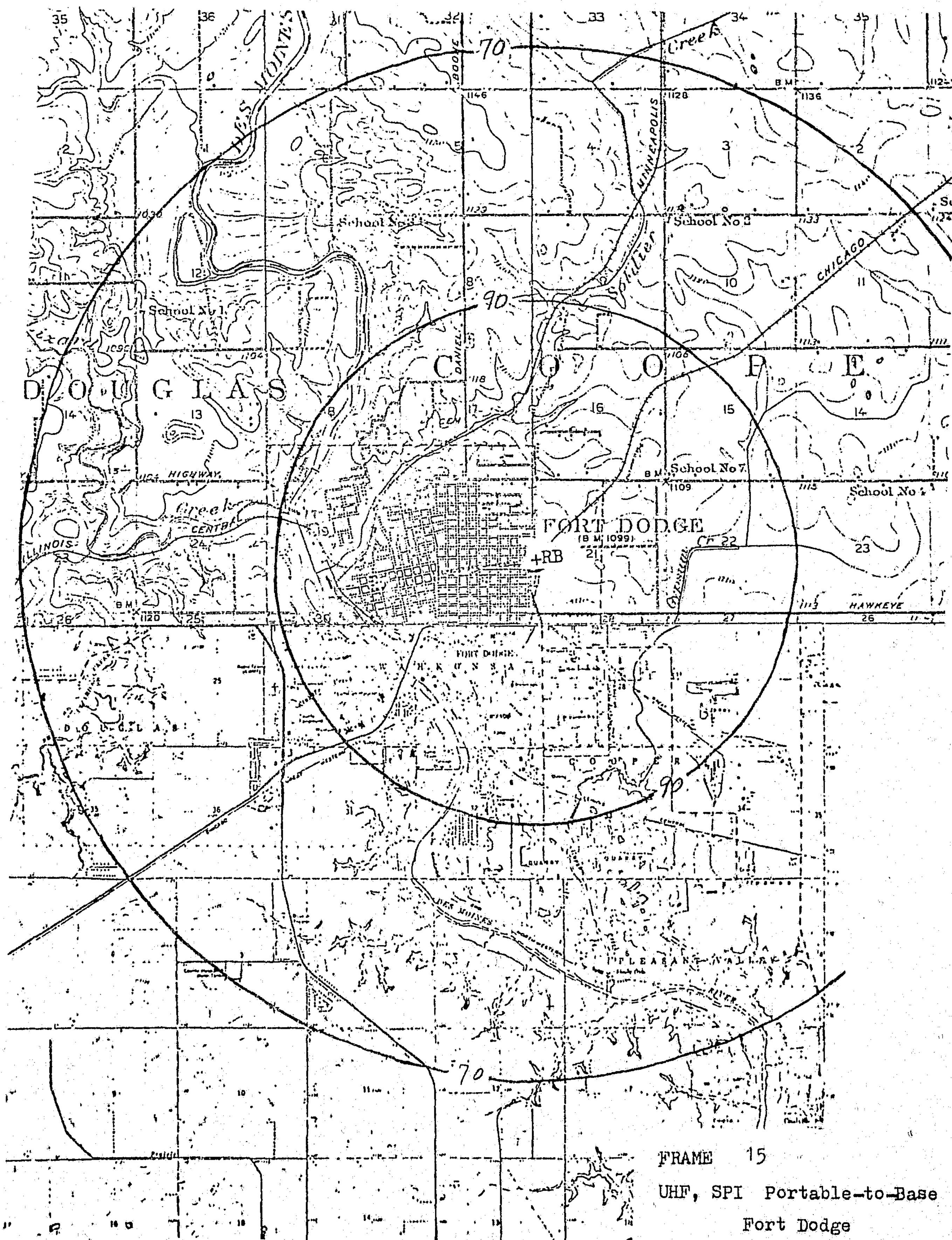


FRAME 13

UHF, SPI Portable-to-Base

Council Bluffs

FRAME 14
UHF, SPI Portable-to-Base
Dubuque



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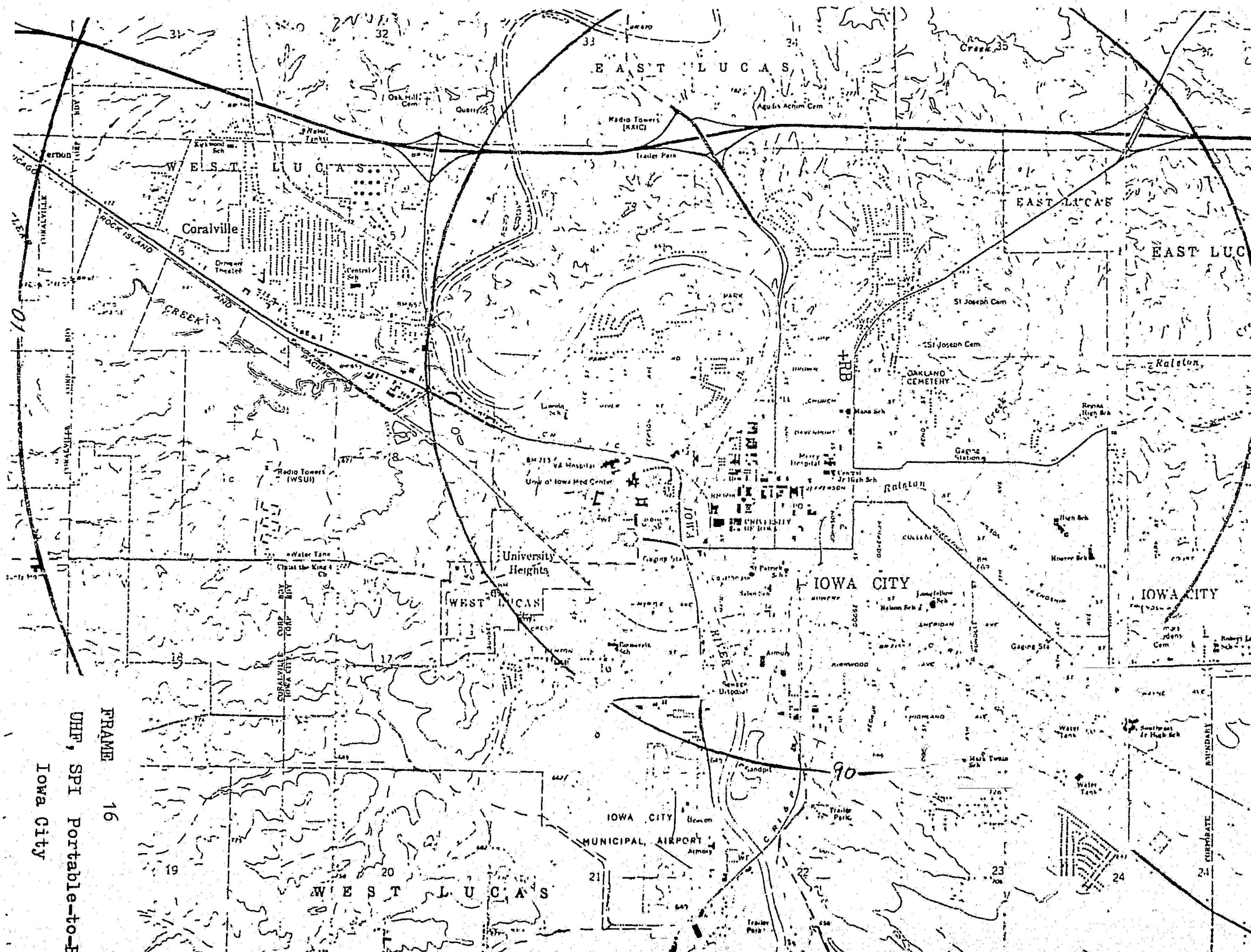
UHF, SPI Portable-to-Base

Fort Dodge



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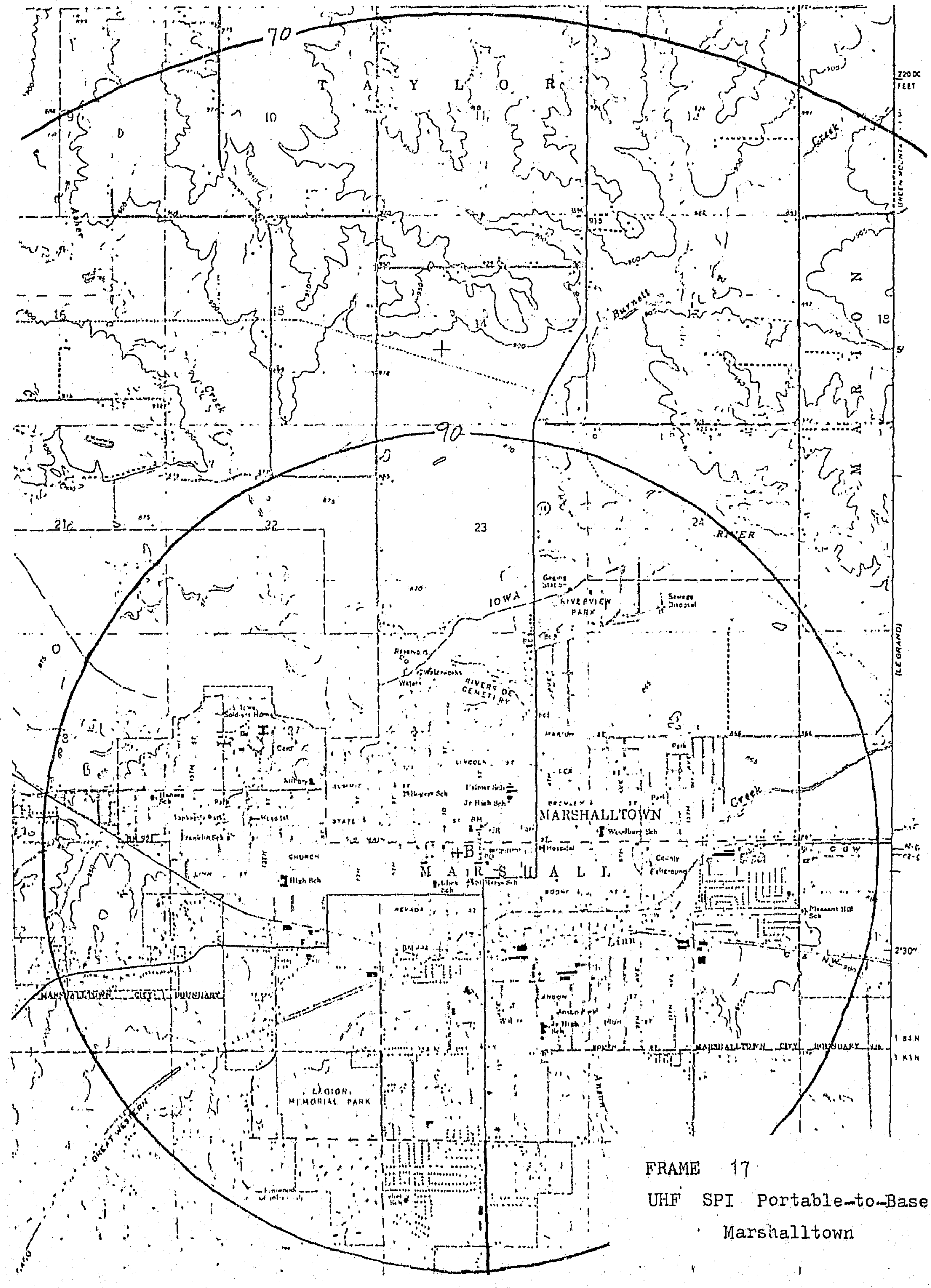
UHF, SPI Portable-to-B

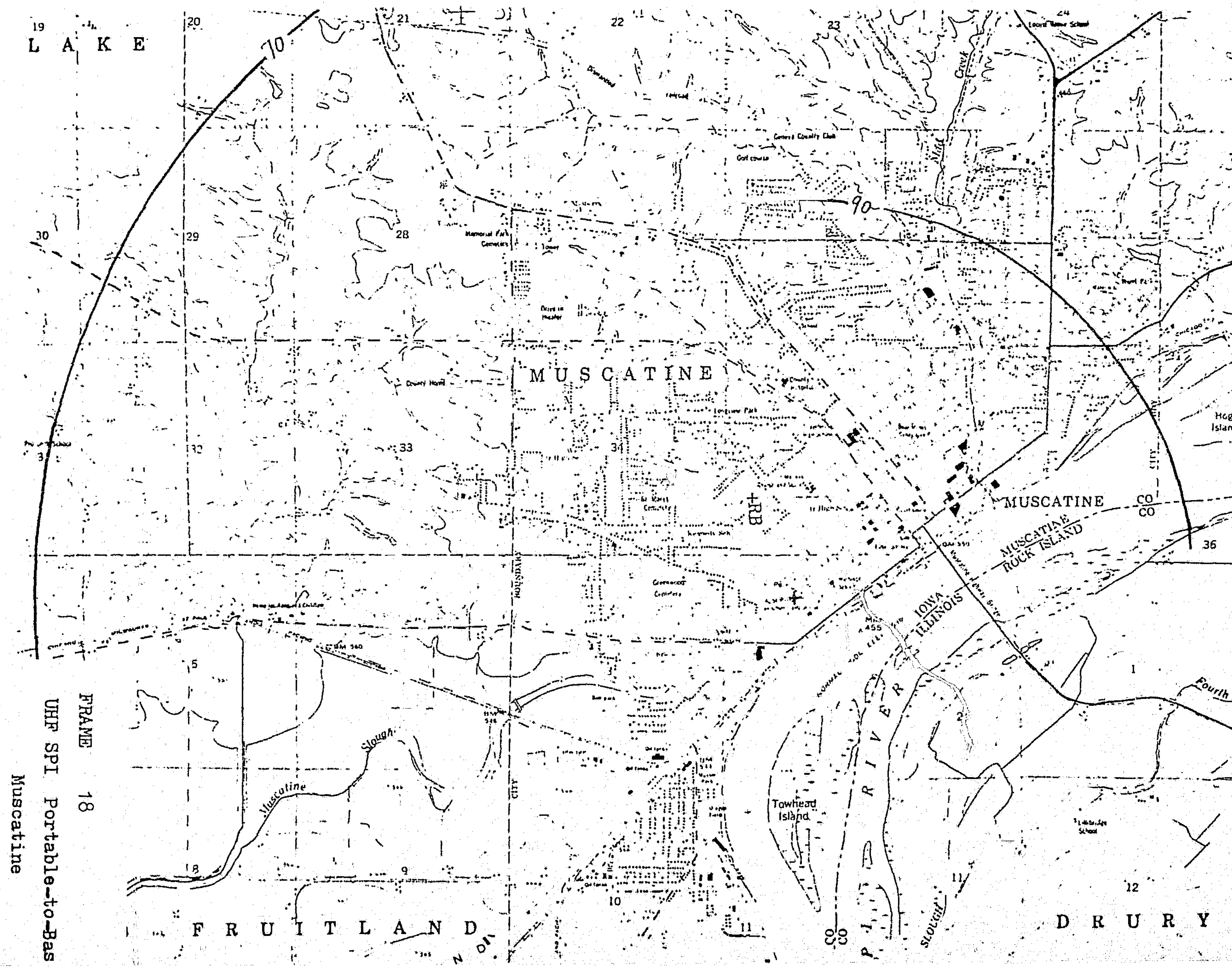
Iowa City



FRAME 17

UHF SPI Portable-to-Base

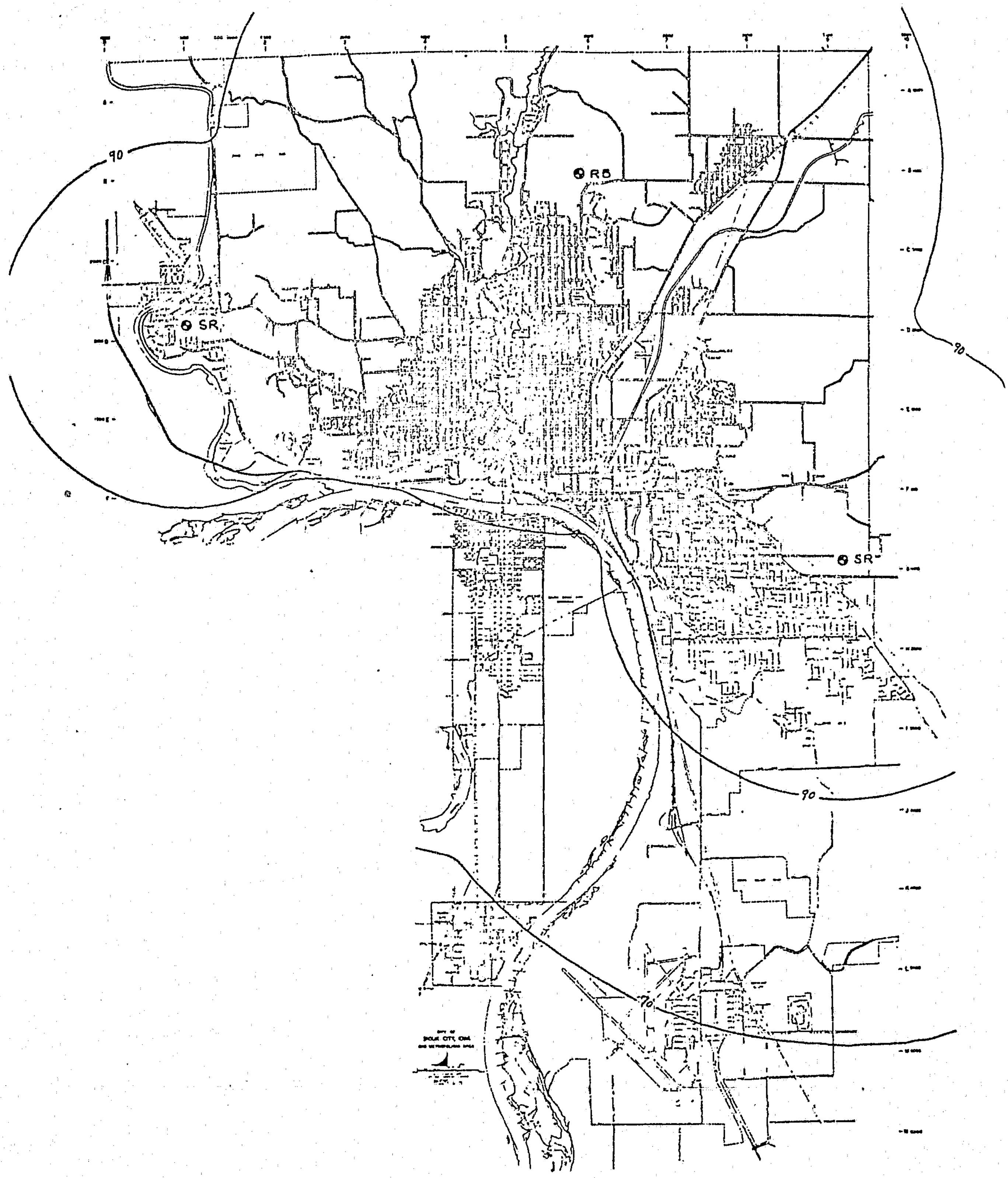
Marshalltown



FRAME 18

UHF SPI Portable-to-Bas

Muscatine



FRAME 19
UHF, SPI Portable-to-Base
Sioux City

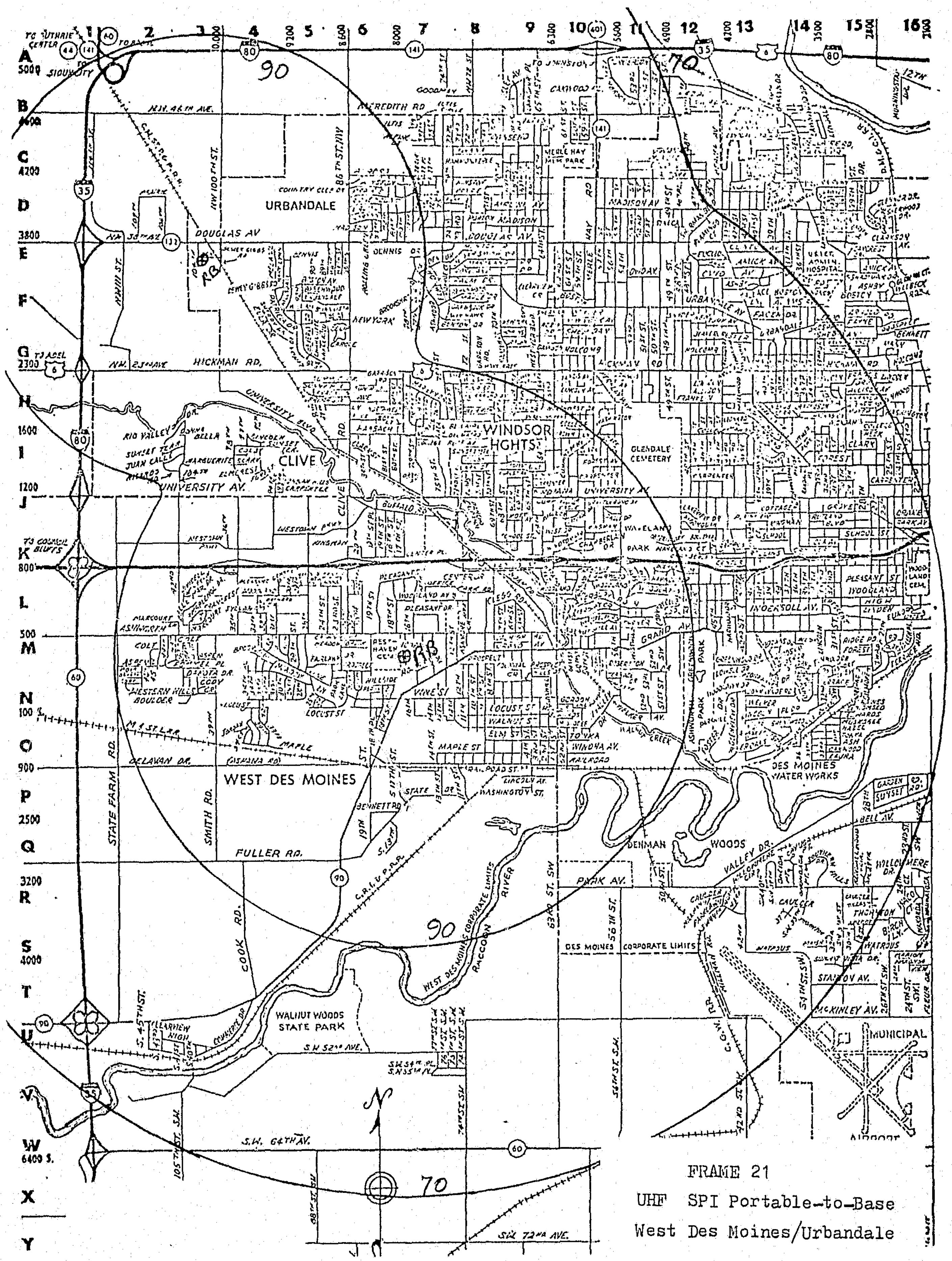
CONTINUED

2 OF 4

FRAME 20

UHF,SPI Portable-to-Base

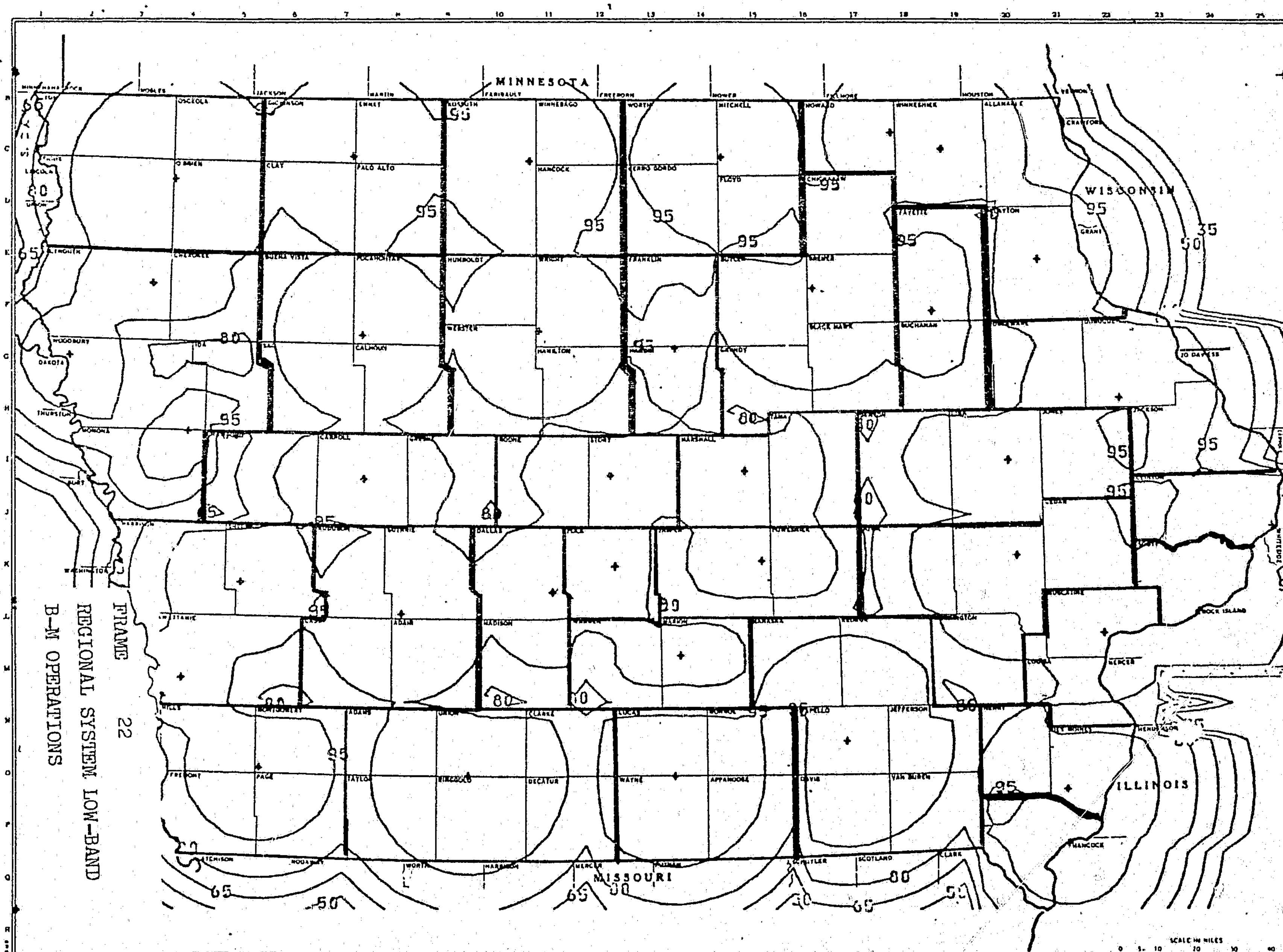
Waterloo



FRAME 21

UHF SPI Portable-to-Base

West Des Moines/Urbandale



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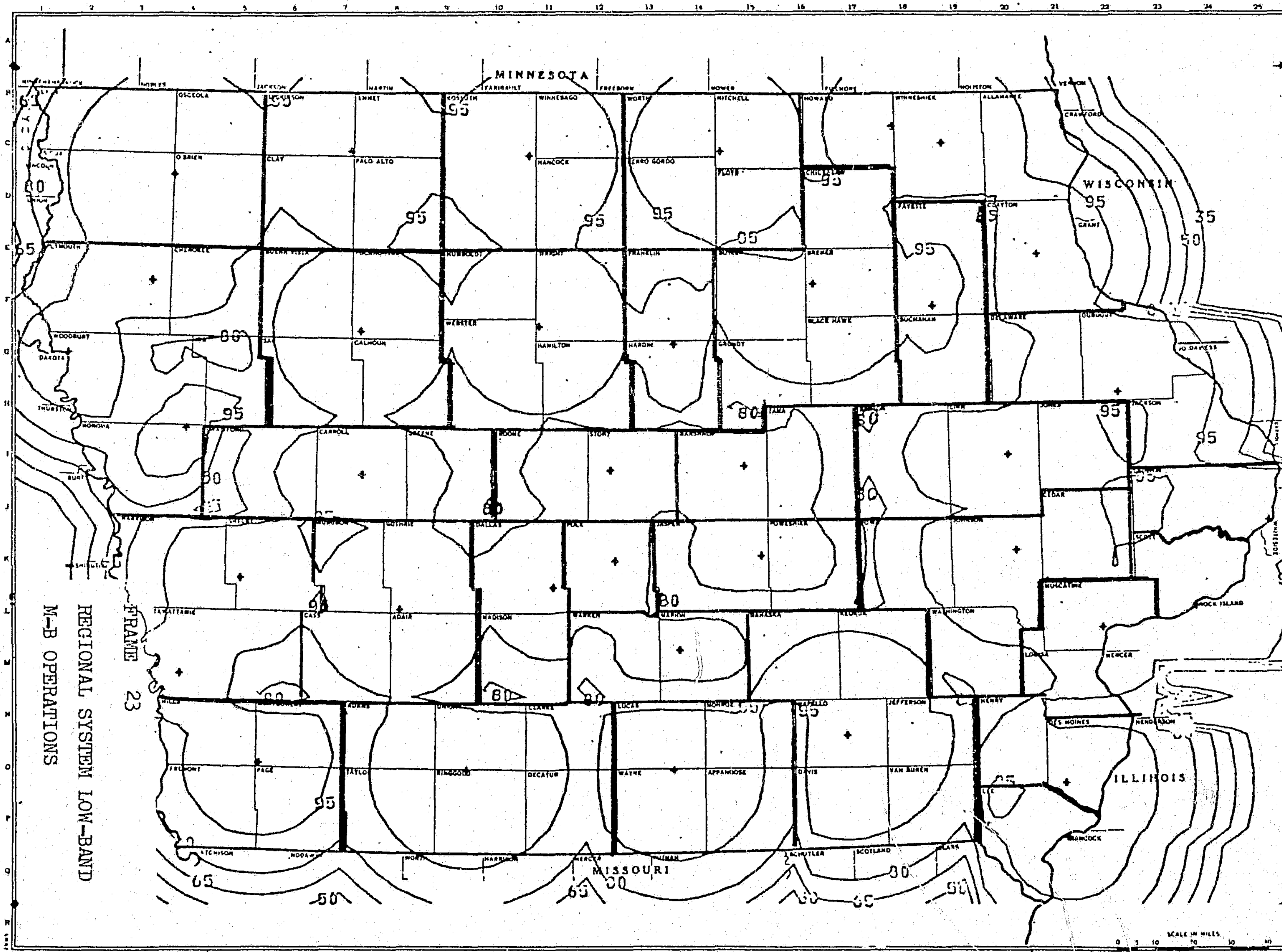
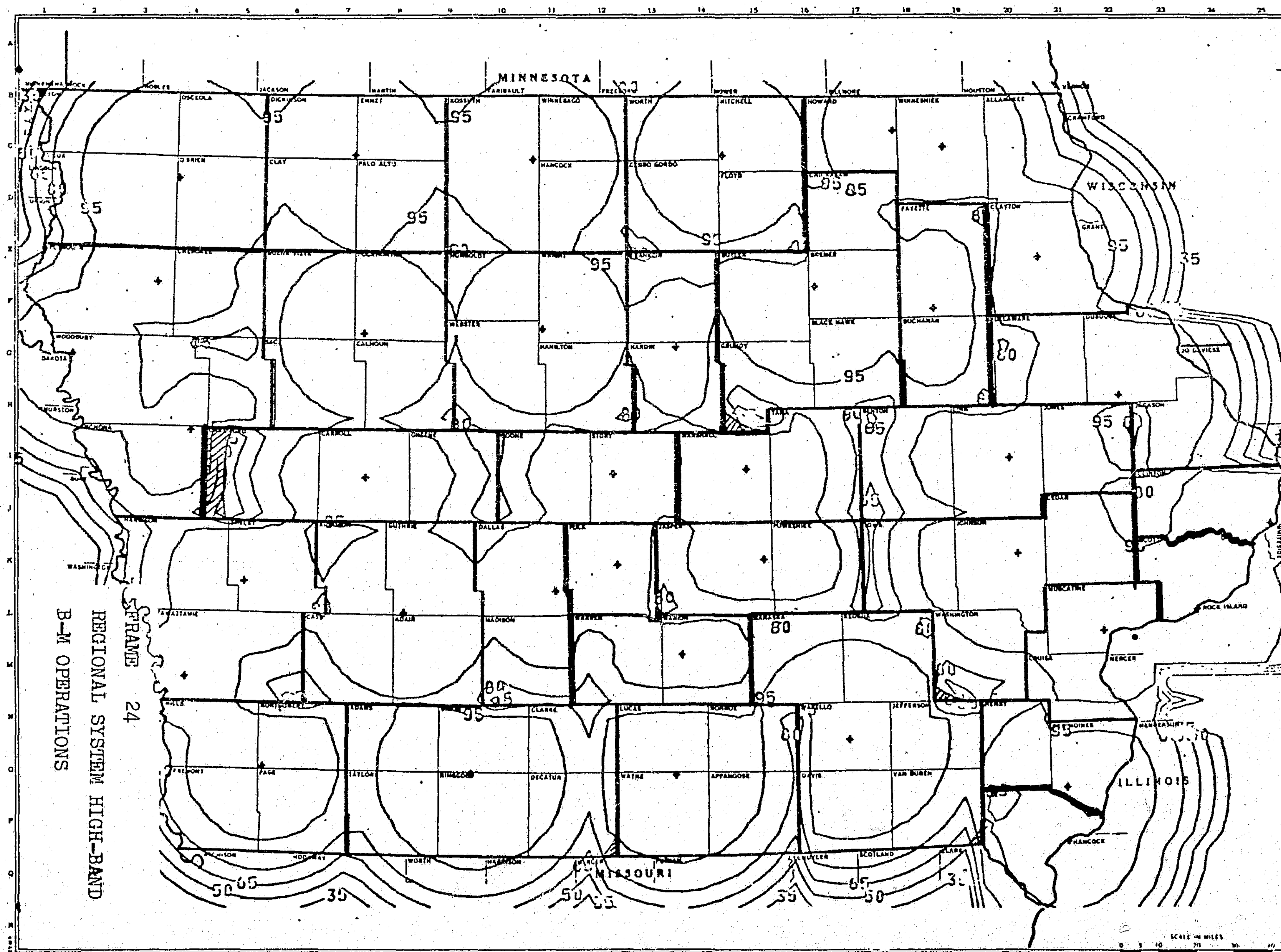
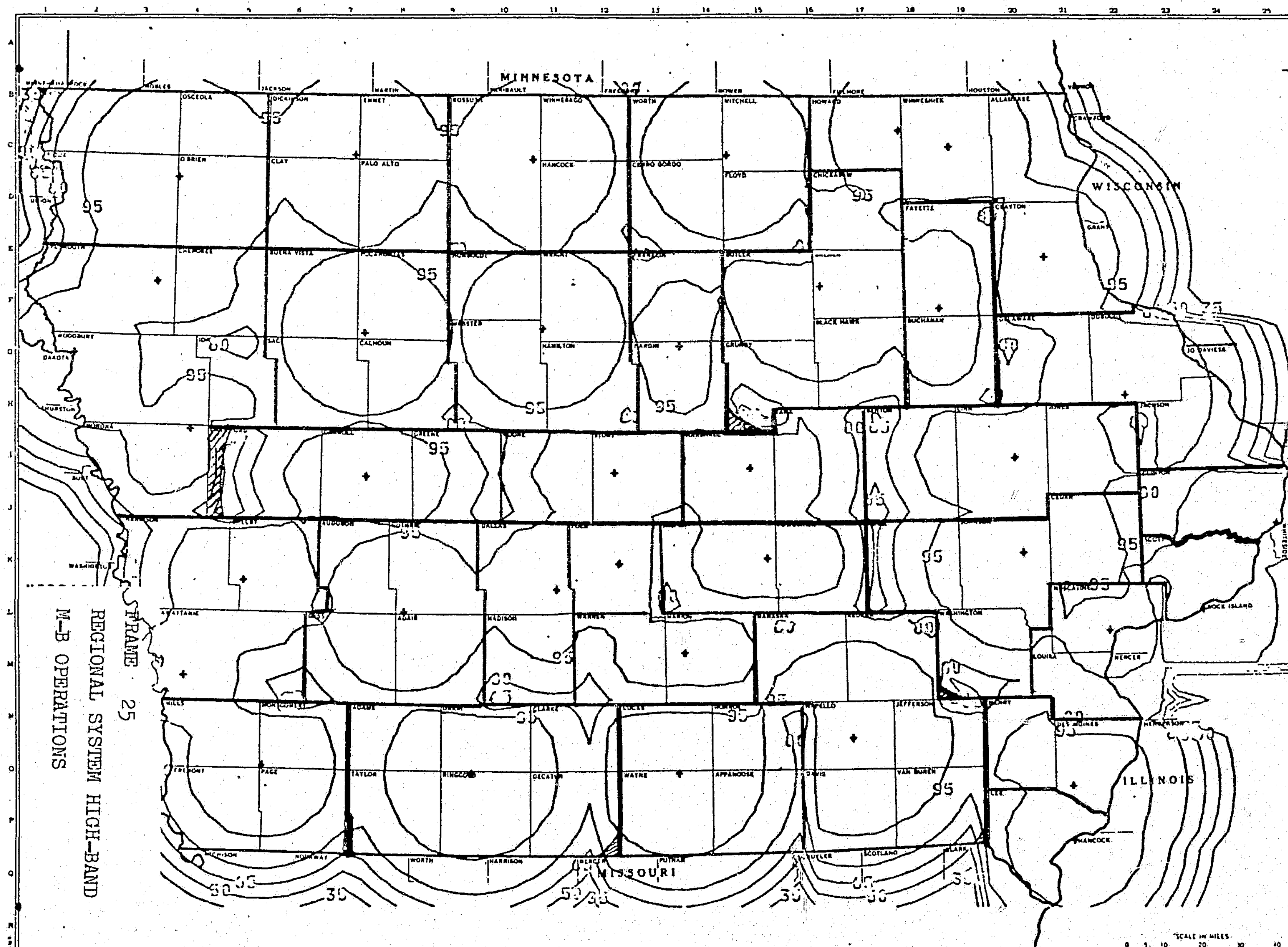
REGIONAL SYSTEM LOW-BAND
B-M OPERATIONS



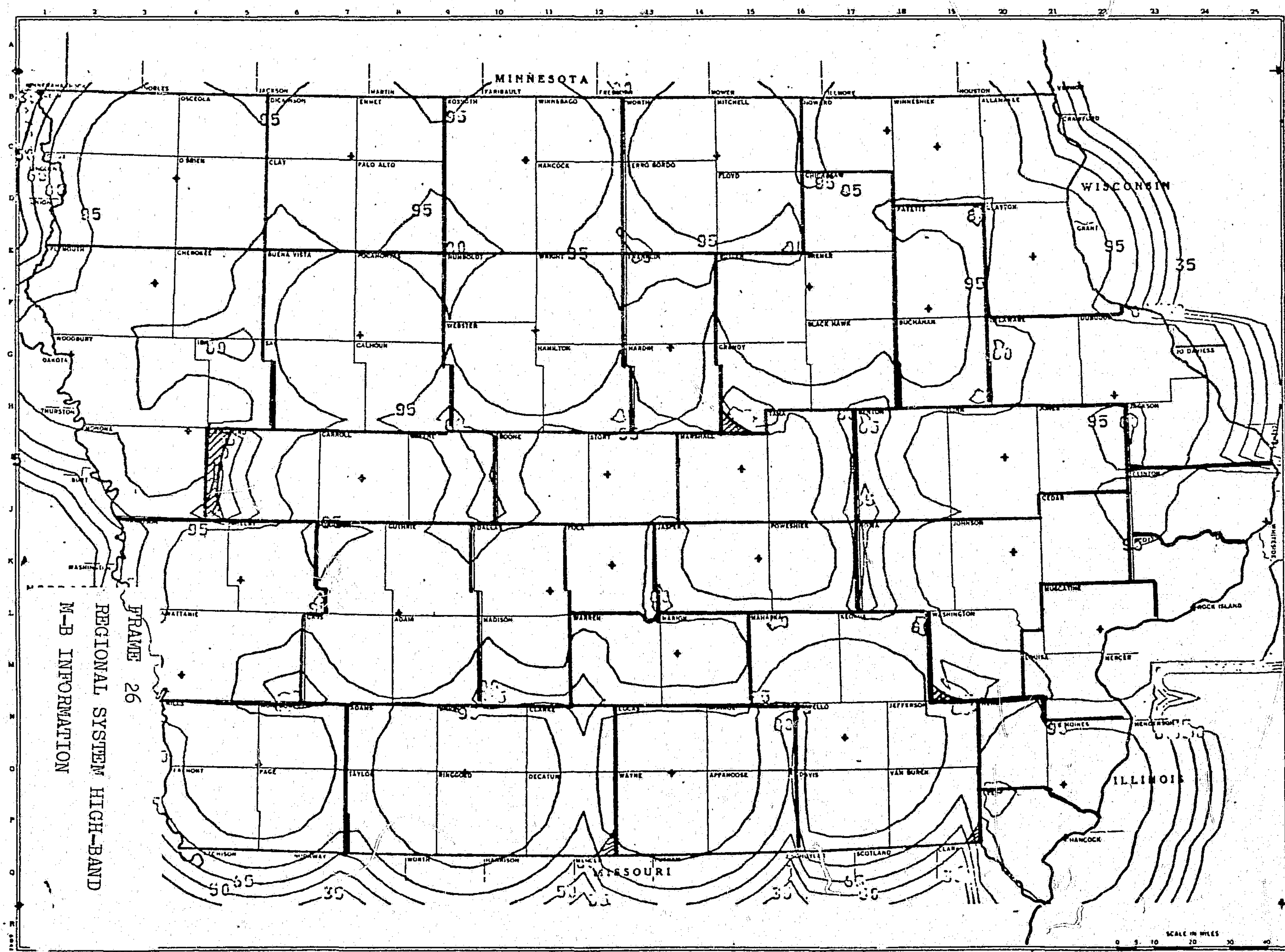
REGIONAL SYSTEM LOW-BAND
M-B OPERATIONS
FRAME 23



FRAME 24
REGIONAL SYSTEM HIGH-BAND
B-M OPERATIONS



FRAME 25
REGIONAL SYSTEM HIGH-BAND
M-B OPERATIONS



FRAME 26
REGIONAL SYSTEM HIGH-BAND
M-B INFORMATION

4.4 BUDGETARY COST ESTIMATES FOR PLANNING

Budgetary cost estimates are prepared for both the county-wide system and the municipal systems for cities over 20,000 population. The Executive Summary contains an overall cost summary by year (Volume I Figure 1-3) for hardware procurement by broad categories. The details by county and major city which provided the background data for the summary are presented in this section of the report. The detailed data provides county and city planners budgetary information for planning budgets and preliminary grant applications.

4.4.1 COUNTY SYSTEMS

Table 4-16 shows system costs by county based on applying the generic system costs found in Table 4-17 for the high-band Tactical and for either the low-band or high-band Operations Channel systems.

The following are additional comments relative to each column of the Table 4-16.

Number of Mobiles, Sheriff - Actual data was used mail survey forms where available. Other agency mobile count is estimated based on a combination of radio message traffic loading predictions as shown in Table 3-4. The estimated mobile count is the radio message loading in Erlangs multiplied by the average of 200 (mobiles/Erlang) which is derived from a comparison with similar population density counties having known mobile numbers. The total number of mobiles in service assumed for sheriff agencies is somewhat less than shown in Phase I Final Report and is believed to be a more realistic number.

NOTE: These are approximations used to establish budgetary estimates for a state-wide total and should not be used for actual grant applications or purchase requisitions. Each county should prepare estimates based on substantiated actual requirements when making applications for equipment grants.

Number of Mobiles, City	This number represents the additional mobiles in the county outside the sheriff's department which are required by towns and cities (including those on UHF) for implementing the Tactical (Mutual Aid) system. The same procedure as used for estimating the sheriff's mobile count was used to determine the mobile counts for cities not responding to the survey.
Total Mobiles	The sum of the sheriff department and city LEA mobile counts or estimates
Tactical Mobile Costs	A 4-frequency, 100 - watt unit is estimated to have a list price of approximately $1,400 and this cost is multiplied by the total number of mobiles operating in the county.
LB Upgrade Frequency Changes, Base and Mobiles	Table 4-17, County System Equipment Listing For Budgeting, shows changes required and potentially necessary to upgrade existing low-band systems currently not crystalled per new frequency plan. A sum of $600 is estimated for recrystalling the base transmitter and receiver, replacing antenna and transmission line, and includes the cost to recrystal mobile units in the county.
HB Tactical Information System (Generic)	A cost for a Tactical/Information generic base station is used as shown in Table 4-16. The sum of $16,731 is rounded off to $16,800 for average use in county estimates.
HB Operations (Generic)	If the HB Operations system is implemented to replac a low-band Operations system, another $6,000 for radio communication equipment is required. Table 4-17 shows the equipment complement cost detail for this option.
HB Personal Portables	The number of personal portables required in any county is estimated to be equivalent to the number of mobiles in use. The cost per county, thus is

the total mobile county per county multiplied by the cost per portable, $1,400. For cities with UHF systems, the number of HB personal portables allocated for coordinated missions with county law enforcement agencies is budgeted as follows:

UHF Municipal Mobiles	Personal Portables
1 - 10	1
11 - 20	2
21 - 30	3
31 - 40	4
41 - 50	5
51 - 75	6
76 - 100	7
101 - 150	8
151 - 200	9
201 - 250	10

Many agencies will need the vehicular charger and accessories to permit operating the portable as a backup mobile unit. This is particularly useful during periods when the Tactical (155.475) priority channel has become fully loaded in one sector of a jurisdiction and normal activity needs to be continued on the high-band Operations Channel in the balance of the jurisdictional and normal activity needs to be continued on the high-band Operations Channel in the balance of the jurisdiction. The additional cost for the mobile accessories is approximately $200.00 which has been included with the portable unit cost estimate.

Communication Center	– – Table 4-17 provides a typical listing of Communication Center equipment and accessories with an estimated cost which is used throughout the county systems cost. As will be noted, the cost for refurbishing buildings, electrical wiring, intrusion alarms, etc. have not been included. Other items such as voice privacy units are also too variable in determining agency needs for security of transmissions and are included in the equipment complement pricing.
LB/HB System	– – The LB/HB cost figure includes costs summed by the county excluding the HB Operations system costs.
HB System	– – The all HB system cost figures include costs summed by county excluding the LB upgrade frequency changes.

The budgetary cost per unit is based on 1973 catalog list prices. Further detailed design or redesign of existing systems to incorporate the changes is required to upgrade each agency's equipment to meet the plan herein provided. The "Spec. Ident" refers to the equipment specifications provided in the Appendix to Volume I.

4.4.2 MUNICIPAL SYSTEMS (UHF)

Table 4-18 lists the budgetary cost estimates for the UHF municipal systems for the cities planned for implementation. Table 4-14 describes the various UHF systems and is used as the basis for the cost estimate. The single channel systems are grouped in one part of the table and differ primarily in the antenna support structure requirements.

The major cities (50,000 or more population) vary in the number of channels implemented and also the availability of existing antenna support structures (water towers, etc.). All UHF systems were planned according to individual community needs and known constraints imposed by the terrain features and the geographical directions of potential growth.

Briefly, the columns of Table 4-18 have the following heading definitions:

QTY	Quantity where specifically known per system in multi-channel systems, multipliers are used or quantities are determined from Table 4-14.
Item/Spec.	System component and specification letter identification reference.
Cost Each	Typically catalog or list prices used by suppliers in 1973.
City Name	Cost breakdown by city and item (if multi-channel) or base and mobile equipment for the generic single channel cities.

The schedule for implementing the UHF systems in the cities is based on the following factors:

1 - Shortage of channels in existing system
2 - Age of existing equipment
3 - Existing system operating on low-band
4 - Contiguous with an installed UHF system

Thus, excluding special consideration for other factors (e.g. Burlington, midway in planning change over to UHF), the time-phased implementation sequence evolved is shown in Table 4-19.

4.4.3 TIME PHASED COST AND SCHEDULE SUMMARY

As shown in the Executive Summary of Volume I, Figure 1-3 depicts the budget dollars required annually, 1974-1978 to implement the system throughout the state. The data utilized to prepare Figure 1-3 is presented in Table 4-20. A seven percent (7%)/year inflationary factor (not compounded) is used to adjust dollar budgets for future years.

The suggested upgrade for specific frequency regions and counties is shown by year Table 4-20 and these are in agreement with the proposed update schedule for the IHPR systems. By following a similar schedule, the Wide-Area repeater system will be available when the county-wide system is completed.

Costs shown for procuring the high-band portable units are based on the initial procurements of portables of one for fi e (5) mobile units the first year of operation and the balance being procured the following year should the individual agency substantiate a need for the additional personal portable units.

In summary. the exact amount of effort required to upgrade any one county is unknown. The condition of existing equipment will need to be assessed by competent technicians and an estimate made to provide the necessary changes to comply with t Iowa Telecommunications Plan.

4.4.4 ESTIMATED COSTS - 911 OPERATION AND INSTALLATION

In cooperation with Northwestern Bell Telephone Company officials and analysts, a detailed 911 installation and operations cost estimate was prepared for selected counties and cities throughout the state.

Costs were established on the basis of expected rate increases. Selection of these representative entities was based upon the desire to compare areas which are typical of the generic communications areas of Iowa. These are:

(1) Small population class -
Clay County having a 1970 population of 18,464, Spencer (county seat) having a 1970 population of 10,278. This community is representative of approximately eighty-two (82) small population counties having an average population of 16,165 with all county seat cities and other cities of under 20,000 maximum population.

(2) Medium population class -
Wapello County having a 1970 population of 42,149, Ottumwa (county seat) having a 1970 population of 29,610. This community is representative of ten (10) medium population counties having an average county population of 49,977 and an average city population of 32,205. All cities in this class are between 20,000 and 50,000.

(3) <u>Large population class</u> -

Blackhawk County having a 1970 population of 132,916, Waterloo, Cedar Falls, Evansdale having a combined 1970 (urban) population of 109,245. This community is representative of seven (7) large population counties having an average county population of 143,610 and an average city population of 106,117. All metropolitan areas have a population in excess of 50,000.

(4) <u>Polk County and Des Moines</u> -

This metropolitan area (242,305) serves the largest population county in the state (286,101) and is considered singularly important both for comparison with other generics and to show the relatively low cost per person of this service.

In preparation of estimates, two conditions for analysis were established:

Condition (1):

The 911 system installation and operation costs were estimated for serving toll-free the metropolitan area of each generic community.

Condition (2):

The 911 system installation and operations costs were estimated for the entire county selected.

NOTE: The county jurisdictional boundaries do not limit the 911 service for it extends to all main stations served by the wire centers and this service often extends into adjacent counties, even though wire centers are within the selected county boundaries. Methods for handling emergency requests from an adjacent county must be cooperatively developed by county authorities.

Each of the selected generic areas under condition(2) is unique and it must be realized that projections to other equivalent sized counties for installation and monthly operating costs are not possible due to the differences in the number of:

(a) Wire centers per county,

(b) Local circuits required for Comm Center "handoff" calls, i. e. fire departments, etc.

(c) Dedicated remote trunks to wire centers.

These numbers associated with each of these items have a major control over operating costs.

The following lists show the costs for each generic county and city system for total "911" system installation, monthly operations and operations per month per person served (approximately). The items of trunk and equipment are listed for each.

(1) Small population generic:

Clay County

Spencer Communications Center - $3,372.70 month, $3,470.00 installation including:

- Two multiline recessed key arrangements for answering positions
- Three metropolitan 911 trunks for Spencer
- Thirty-two 911 trunks for remote wire centers
- Two operator completion trunks for dial "0" calls
- Two local dispatch circuits, one each for fire and sheriff

Per month operating cost per population unit is $0.18.

Spencer, Iowa - $215.00 month, $490.00 installation including:

- Two multiline key arrangements for answering positions
- Three 911 trunks for Spencer
- Two operator completion trunks for dial "0" calls
- Two local circuits for handoff calls

Per month operating cost per population unit is $0.021.

Ratio of county/city costs = 8.6

Ratio of county/city populations = 1.8

(2) Medium population generic:

Wapello County

Ottumwa Communications Center - $2,255.90 month, $2,870.00 installation including:

- Two multiline recessed key arrangements for answering positions
- Three metropolitan 911 trunks for Ottumwa
- Twenty-four 911 trunks for remote wire centers
- Two operator completion trunks for dial "0" calls
- One local radio control channel
- Two local dispatch circuits, one each for fire and sheriff

Per month operating cost per population unit is $0.053.

Ottumwa, Iowa - $256.20 month, $585.00 installation including:

- Two multiline key arrangements for answering positions
- Four 911 trunks for Ottumwa
- Two operator completion trunks for dial "0" calls
- Three local circuits for handoff calls

Per month operating cost per population unit is $0.009

Ratio of county/city costs = 5.9

Ratio of county/city populations = 1.42

(3) Large population generic:

Blackhawk County

Waterloo Communications Center - $3,111.90 month, $4,160.00 installation including:

- One 310 PBX switching system with three consoles
- Seven metropolitan 911 trunks for Waterloo
- Eighteen 911 trunks for remote wire centers
- Five radio control circuits
- Two operator completion trunks for dial "0" calls
- Eight local dispatch circuits, Waterloo and Cedar Falls fire houses and county sheriff

Per month operating cost per population unit is $0.023.

Waterloo including Cedar Falls and Evansdale - $630.00 month, $1,320.00 installation including:

- Three multiline key arrangements for answering positions
- Seven 911 trunks to serve Waterloo and Evansdale
- Four remote 911 trunks to Cedar Falls
- Two operator completion trunks for dial "0" calls
- One fire dispatch circuit to Cedar Falls
- Three local circuits for handoff calls

Per month operating cost per population unit is $0.006.

Ratio of county/city costs = 3.8

Ratio of county/city populations = 1.22

(4) Polk County, Des Moines (Metro Area)

Polk County

Des Moines Communications Center - $6,554.00 month, $8,305.00 installation including:

- One 310 PBX dispatch switching system with five consoles at main Comm Center
- One additional backup console at fire department
- Eighteen 911 trunks for Des Moines metro area

- Three combination in and out trunks for dialable service
- Thirty-nine 911 trunks for remote wire centers
- Five local handoff circuits to Des Moines Fire Department
- Twenty-three local dispatch circuits for suburban police and fire
- Five operator completion trunks for dial "0" calls
- Eight local dispatch circuits on-premise to police department

Per month operating cost per population unit is $0.023.

Des Moines, Iowa - $2,986.00 month, $,665.00 installation including:

- Same equipment arrangement as county-wide but excluding:
  - Thirty nine 911 trunks to remote wire centers and associated line equipment.

Per month operating cost per population unit is $0.012.

Ratio of county/city costs = 1.9

Ratio of county/city population = 1.18

Comparison ratios of cost to population between total county and city-only 911 services show, in the small and medium generic systems, a relatively large cost for expansion of the 911 service area from the population center to the entire county. Forty-nine percent (49%) of the state population would be serviced by the 911 city-only system.

It is a safe assumption that the per capita operating costs would be less than two (2) cents per month if the county seat city areas (plus Ames) were served by "911". This cost would provide "911" service to half the population of the state.

It is recommended that emergency request planning in each county include a provision for achievement of 911 service for county seat cities and especially for cities having a population exceeding 10,000. Larger metropolitan areas should include an area which extends to the toll-free service boundaries.

TABLE 4-16 COUNTY-WIDE SYSTEMS BUDGETARY COST ESTIMATES

NOTE: Number of sheriff's mobiles if underlined is from mail survey information, all others are estimated.

Co. No.	Freq. Region	County (Co. Seat)	No. of Mobiles Sheriff	No. of Mobiles City	Total Mobiles	Highband Mobile Cost @ $1400/ea.	LB Upgrade Freq. Changes B and M's	HB Tactical Info Sys (Generic)	HB OPS (Generic)	HB Personal Portable @ $1400/ea.	Comm Center Equipment*	LB/HB System	HB System
1	19	Adair (Greenfield)	2	4	6	$ 8,400	$ 1,200	$ 16,800	$ 6,000	$ 8,400	$ 18,150	52950	57750
2	27	Adams (Corning)	3	3	6	8,400	1,200	16,800	6,000	8,400	18,150	52950	57750
3	5	Allamakee (Waukon)	4	8	12	16,800	1,800	16,800	6,000	16,800	18,150	70350	74550
4	28	Appanoose (Centerville)	2	3	5	7,000	1,100	16,800	6,000	7,000	18,150	50050	54950
5	19	Audubon (Audubon)	3	4	7	9,800	1,300	16,800	6,000	9,800	18,150	55850	60550
6	16	Benton (Vinton)	3	0	3	4,200	1,000	16,800	6,000	4,200	18,150	44350	49350
7	10	Blackhawk (Waterloo)	9	70	79	110,600	–	16,800	6,000	22,400	18,150	167950	173950
8	14	Boone (Boone)	3	4	7	9,800	1,300	16,800	6,000	9,800	18,150	55850	60550
9	10	Bremer (Waverly)	1	3	4	5,600	1,000	16,800	6,000	5,600	18,150	47150	52150
10	11	Buchanan (Independence)	10	5	15	21,000	2,100	16,800	6,000	21,000	18,150	79050	82950
11	7	Buena Vista (Storm Lake)	17	11	28	39,200	–	16,800	6,000	39,200	18,150	113350	119350
12	10	Butler (Allison)	4	8	12	16,800	1,800	16,800	6,000	16,800	18,150	70350	74550
13	7	Calhoun (Rockwell City)	20	9	29	40,600	–	16,800	6,000	40,600	18,150	116150	122,150
14	13	Carroll (Carroll)	9	6	15	21,000	2,100	16,800	6,000	21,000	18,150	79050	82,950
15	19	Cass (Atlantic)	2	5	7	9,800	1,300	16,800	6,000	9,800	18,150	55850	60550
16	24	Cedar (Tipton)	4	8	12	16,800	1,800	16,800	6,000	16,800	18,150	70350	74550
17	4	Cerro Gordo (Mason City)	20	32	52	72,800	–	16,800	6,000	32,200	18,150	139950	145950
18	6	Cherokee (Cherokee)	4	6	10	14,000	1,600	16,800	6,000	14,000	18,150	64550	68950
19	10	Chickasaw (New Hampton)	10	11	21	29,400	2,700	16,800	6,000	29,400	18,150	96450	99750
20	27	Clarke (Osceola)	4	4	8	11,200	1,400	16,800	6,000	11,200	18,150	58750	63350
21	2	Clay (Spencer)	8	3	11	15,400	1,700	16,800	6,000	15,400	18,150	67450	71750
22	5	Clayton (Elkader)	4	5	9	12,600	1,500	16,800	6,000	12,600	18,150	61650	66150
23	17	Clinton (Clinton)	23	31	54	75,600	6,000	16,800	6,000	36,400	18,150	152950	152950
24	13	Crawford (Denison)	5	6	11	15,400	1,700	16,800	6,000	15,400	18,150	67450	71750
25	20	Dallas (Adel)	3	21	24	33,600	–	16,800	6,000	33,600	18,150	102150	108150
26	29	David (Bloomfield)	3	5	8	11,200	1,400	16,800	6,000	11,200	18,150	58750	63350
27	27	Decatur (Leon)	2	3	5	7,000	1,100	16,800	6,000	7,000	18,150	50050	54950
28	12	Delaware (Manchester)	4	6	10	14,000	1,600	16,800	6,000	14,000	18,150	64550	68950
29	30	Des Moines (Burlington)	30	13	43	60,300	4,900	16,800	6,000	44,800	18,150	144950	146050
30	2	Dickenson (Spirit Lake)	6	2	8	11,200	1,400	16,800	6,000	11,200	18,150	58750	63350
31	12	Dubuque (Dubuque)	11	21	32	44,800	3,800	16,800	6,000	18,200	18,150	101750	103950
32	2	Emmet (Esterville)	9	1	10	14,000	1,600	16,800	6,000	14,000	18,150	64550	68950

TABLE 4-16 Page 2 COUNTY-WIDE SYSTEMS BUDGETARY COST ESTIMATES

Co. No. & Freq. Region	County (Co. Seat)	No. of Mobiles Sheriff	No. of Mobiles City	Total Mobiles	Highband Mobile Cost @ $1400/ea.	LB Upgrade Freq. Changes B and M's	HB Tactical Info Sys (Generic)	HB OPS (Generic)	HB Personal Portable @ $1400/ea.	Comm Center Equipment*	LB/HB System	HB Syste
33 11	Fayette (West Union)	9	11	20	28,000	2,600	16,800	6,000	28,000	18,150	93550	96950
34 4	Floyd (Charles City)	3	2	5	7,000	1,100	16,800	6,000	7,000	18,150	50050	54950
35 9	Franklin (Hampton)	4	6	10	14,000	1,100	16,800	6,000	14,000	18,150	64050	68950
36 18	Fremont (Sidney)	3	3	6	8,400	1,200	16,800	6,000	8,400	18,150	52950	57750
37 13	Greene (Jefferson)	3	4	7	9,800	1,300	16,800	6,000	9,800	18,150	55850	60550
38 10	Grundy (Grundy Center)	2	3	5	7,000	1,100	16,800	6,000	7,000	18,150	50050	54950
39 19	Guthrie (Guthrie Center)	2	4	6	8,400	1,200	16,800	6,000	8,400	18,150	52950	57750
40 8	Hamilton (Webster City)	4	7	11	15,400	1,200	16,800	6,000	15,400	18,150	66950	71750
41 3	Hancock (Garner)	3	3	6	8,400	1,200	16,800	6,000	8,400	18,150	52950	57750
42 9	Hardin (Eldora)	15	11	26	36,400	3,200	16,800	6,000	36,400	18,150	110950	113750
43 18	Harrison (Logan)	3	2	5	7,000	1,100	16,800	6,000	7,000	18,150	50050	54950
44 30	Henry (Mt. Pleasant)	3	5	8	11,200	1,400	16,800	6,000	11,200	18,150	58750	63350
45 5	Howard (Cresco)	3	3	6	8,400	1,200	16,800	6,000	8,400	18,150	52950	57750
46 8	Humboldt (Dakota City)	4	3	7	9,800	1,300	16,800	6,000	9,800	18,150	55850	60550
47 6	Ida (Ida Grove)	3	3	6	8,400	1,200	16,600	6,000	8,400	18,150	52950	57750
48 24	Iowa (Marengo)	4	5	9	12,600	1,500	16,800	6,000	12,600	18,150	61650	66150
49 12	Jackson (Maquoketa)	16	19	35	49,000	4,100	16,800	6,000	49,000	18,150	137050	138950
50 23	Jasper (Newton)	9	12	21	29,400	2,700	16,800	6,000	29,400	18,150	96450	99750
51 29	Jefferson (Fairfield)	10	5	15	21,000		16,800	6,000	21,000	18,150	76950	82950
52 24	Johnson (Iowa City)	9	18	27	37,800	3,300	16,800	6,000	15,400	18,150	91450	94150
53 16	Jones (Anamosa)	4	6	10	1,400	1,600	16,800	6,000	14,000	18,150	51950	5635
54 29	Keokuk (Sigourney)	5	6	11	15,400		16,800	6,000	15,400	18,150	65750	71750
55 3	Kossuth (Algona)	4	10	14	19,600	2,000	16,800	6,000	19,600	18,150	76150	80150
56 31	Lee (Fort Madison)	6	9	15	21,000		16,800	6,000	21,000	18,150	76950	82950
57 16	Linn (Cedar Rapids)	22	59	81	113,400		16,800	6,000	39,200	18,150	187550	19355
58 25	Louisa (Wapello)	4	4	8	11,200	1,400	16,800	6,000	11,200	18,150	58750	63350
59 28	Lucas (Chariton)	4	5	9	12,600	1,500	16,800	6,000	12,600	18,150	61650	66150
60 1	Lyon (Rock Rapids) *	8	2	10	14,000	1,600	16,800	6,000	14,000	18,150	64550	68950
61 20	Madison (Winterset)	4	4	8	11,200	-	16,800	6,000	11,200	18,150	57350	63350
62 29	Mahaska (Oskaloosa)	5	10	15	21,000		16,800	6,000	21,000	18,150	76950	82950
63 22	Marion (Knoxville)	4	14	18	25,200	2,400	16,800	6,000	25,200	18,150	87750	91350
64 15	Marshall (marshalltown)	8	15	23	32,200		16,800	6,000	16,800	18,150	83950	89950
65 18	Mills (Glenwood)	2	4	6	8,400	1,200	16,800	6,000	8,400	18,150	52950	57750

TABLE 4-16 Page 3 COUNTY-WIDE SYSTEMS BUDGETARY COST ESTIMATES

Co. No.	Freq. Region	County (Co. Seat)	No. of Mobiles Sheriff	No. of Mobiles City	Total Mobiles	Highband Mobile Cost Cost @ $1400/ea.	LB Upgrade Freq. Changes B and H's	HB Tactical Info Sys (Generic)	HB OPS (Generic)	HB Personal Portable @ $1400/ea.	Comm Center Equipment*	LB/HB System	HB System
66	4	Mitchell (Osage)	4	4	8	11,200	1,400	16,800	6,000	11,200	18,150	58750	63350
67	6	Monona (Onawa)	2	6	8	11,200	1,400	16,800	6,000	11,200	18,150	58750	63350
68	28	Monroe (Albia)	3	15	18	25,200	2,400	16,800	6,000	25,200	18,150	87750	91350
69	18	Montgomery (Red Oak)	3	6	9	12,600	1,500	16,800	6,000	12,600	18,150	61650	66150
70	25	Muscatine (Muscatine)	6	25	31	43,400		16,800	6,000	12,600	18,150	90950	96950
71	1	O'Brien (Primghar)	4	5	9	12,600	1,500	16,800	6,000	12,600	18,150	61650	66150
72	1	Osceola (Sibley)	3	3	6	8,400	1,200	16,800	6,000	8,400	18,150	52950	57750
73	18	Page (Clarinda)	4	9	13	18,200	1,400	16,800	6,000	18,200	18,150	72750	77350
74	2	Palo Alto (Emmetsburg)	4	5	9	12,600	1,500	16,800	6,000	12,600	18,150	61650	66150
75	6	Plymouth (LeMars)	7	5	12	16,800	1,800	16,800	6,000	16,800	18,150	70350	74550
76	7	Pocahontas (Pocahontas)	4	7	11	15,400		16,800	6,000	15,400	18,150	65750	71750
77	21	Polk (Des Moines)	35	204	239	334,600		16,800	6,000	63,000	18,150	432500	438550
78	18	Potawatomie (Council Bluffs)	12	34	46	64,400	5,200	16,800	6,000	22,400	18,150	126950	127750
79	23	Poweshick (Montezuma)	4	21	25	35,000	3,100	16,800	6,000	35,000	18,150	108050	110950
80	27	Ringgold (Mt. Ayr)	2	1	3	4,200	900	16,800	6,000	4,200	18,150	44250	49350
81	7	Sac (Sac City) *	1	1	2	2,800		16,800	6,000	2,800	18,150	40550	46550
82	26	Scott (Davenport)	20	55	75	105,000		16,800	6,000	36,400	18,150	176350	182350
83	18	Shelby (Harlan)	4	5	9	12,600	1,500	16,800	6,000	12,600	18,150	61650	66150
84	1	Sioux (Orange City)	7	9	16	22,400	2,200	16,800	6,000	22,400	18,150	81950	85750
85	14	Story (Nevada)	16	17	33	46,200	3,900	16,800	6,000	46,200	18,150	131250	133350
86	15	Tama (Toledo)	8	5	13	18,200	1,900	16,800	6,000	18,200	18,150	73250	77350
87	27	Taylor (Bedford)	3	3	6	8,400	1,200	16,800	6,000	8,400	18,150	52950	57750
88	27	Union (Creston)	4	16	20	28,000	2,600	16,800	6,000	28,000	18,150	93550	96950
89	29	Ban Buren (Keosauqua)	3	7	10	14,000		16,800	6,000	14,000	18,150	62950	68950
90	29	Wapello (Ottumwa)	8	11	19	26,600	2,500	16,800	6,000	12,600	18,150	76650	80150
91	22	Warren (Indianola)	6	11	17	23,800		16,800	6,000	23,800	18,150	82550	86550
92	24	Washington (Wasington)	4	6	10	14,000	1,600	16,800	6,000	14,000	18,150	64550	68950
93	28	Wayne (Corydon)	2	3	5	7,000	1,100	16,800	6,000	7,000	18,150	50050	54950
94	8	Webster (Ft. Dodge)	9	11	20	28,000		16,800	6,000	14,000	18,150	76950	82950
95	3	Winnebago (Forest City)	4	2	6	8,400	1,200	16,800	6,000	8,400	18,150	52950	57750
96	5	Winneshiek (Decorah)	4	4	8	11,200	1,400	16,800	6,000	11,200	18,150	58750	63350
97	6	Woodbury (Sioux City)	14	41	55	77,000	6,100	16,800	6,000	26,600	18,150	144650	144550
98	4	Worth (Northwood)	10	2	12	16,800	1,800	16,800	6,000	16,800	18,150	70350	74550
99	8	Wright (Clarion)	3	7	10	14,000	1,600	16,800	6,000	14,000	18,150	64550	68950
			661	1164	1825	$2,542,500	$ 150,000	$1,663,200	$594,000	$1,741,600	$1,796,850	7,894,150	8,333,150

* On-Site Data

*Excludes Voice Privacy Units

TABLE 4-17 COUNTY SYSTEM EQUIPMENT LISTING FOR BUDGETING

Qty		Spec. Ident.	Budgetary Cost Per Unit	Budgetary Cost Extended
	Low Band Operations Option:			
	Recrystal Base Xmtr.	-	100	100
	Recrystal Base Rcvr.	-		
	Recrystal Mobiles	-	100	X
	Upgrade Antenna	D-8	200	200
	Installation (average)		100	100
	Replace Transmission Line		150	150
	Misc. Hardware		50	50
				600
	High Band Tactical/Info:			
1	Xmtr, 100W, 4f	E	3,500	3,500
5	Receiver	F or F-1 (qty 2)	400-480	2,160
1	Antenna	D-4 thru D-7	200	200
200	Transmission Line	(Typical)	400	400
	Control Console Mods	U	2,500	2,500
200'	Antenna tower	T	6,600	6,600
1	Antenna Coupler	G	450	450
	Installation (10% of hardware costs) less tower installation)			921
				16,800
	High Band Operations Option:			
1	Xmtr, 100w, 1f	E	2,500	2,500
1	Rcvr.	F	480	480
1	Tactical/Info Filter	J	300	300
1	Operation Chan Filter	H	300	300
1	Supplementary Filter	I	210	210
1	Antenna	Various	200	200
200	Transmission Line	(Typical)	400	400
	Control Console Mods	U	1,000	1,000
	Installation (10% of hardware costs)			539
				6,000
	Communications Center:			
	TRACIS Terminal	-	Leased	Leased
	Multi-chan. recorder	O	10,000	10,000
	Control Consoles	U	3,000	3,000
	Telephone System	-	TBA	TBA
	Emerg. Power Source	R	2,500	2,500
	Secure room		Variable	Variable
	Phone Patch	X	350	350
	Voice Privacy Units:	W		
	Base	W	1,000	
	Mobile	W	600	X
	Telephone	W	500	X
	Intrusion alarm panel		TBA	TBA
	Person.Port.Battery Charger		650	650
	Installation (10% of hardware costs)			1,650
				18,150 *
	Mobile Units:			
	HB Tactical	M	1,400	X
	Portables:	-		
	HB (4W)	Q	1,400	X

* Excluding Voice Privacy Units

Table 4-18A UHF MUNICIPAL SYSTEMS BUDGETARY COSTS

ONE CHANNEL SYSTEM

Qty	Item	Spec.	Cost Each	Extended Cost
1	UHF Transmitter	A-1	$ 3,000	$ 3,000
1	UHF Receiver	B-1	630	630
1	Duplexer	C	345	345
1	Antenna Tower (200')	T	6,600	6,600
1	Antenna	D-1 / D-2	160	160
250'	Transmission Line & Fittings	L	15	15
	Installation			475
				$ 11,825
X	Transceivers (mobile)	N	1,250	
or				
Y	Personal Portables with mobile mounts	P-2	1,465	
Z	Personal Portables (non-mobile mtg)	P-1	1,200	
	COMM CENTER			
	TRACIS Terminal	N/A	leased	
	Multichannel Recorder	O	10,000	10,000
	Control Console	U	7,000	7,000
	Emergency Power	R	2,500	2,500
	Phone Patch	X	350	350
	Personal Port. Battery Charger	Y	650	650
	Installation			2,050
				$ 22,550
	OPTIONS			
	Voice Privacy Unit	W		
	Base		1,000	
	Mobile		600	
	Portable		450	
	Telephone		500	
	Intrusion Alarm Panel		various	
				$ 34,375

CITY SUMMARY

City	Base & Comm Center		UHF Mobile/Port Costs*	Total Cost (1973 level)
Ames	$ 34,375	10	$ 16,120	$ 50,495
Bettendorf	34,375	9	14,504	48,879
Burlington	12,775	13	20,950	33,725
Cedar Falls	34,375	11	17,727	52,102
Clinton	34,375	31	49,957	84,332
Ft. Dodge	34,375	11	17,727	52,102
Marshalltown	34,375	15	24,173	58,548
Muscatine	34,375	10	16,120	50,495
W. Des Moines	27,775	30	48,346	76,121

* Includes Installation

UHF MUNICIPAL-BUDGETARY COSTS

TABLE 4-18B MULTI-CHANNEL SYSTEM

Qty	ITEM	Spec.	Cost Each	Iowa City 2(chans)	Council Bluffs 3(chans)	Sioux City (3+1 Chans)	Cedar Rapid (5 chans)	Dubuque (2 chans)
				CITY SUMMARY				
1 / chan	UHF Transmitter	A-1 or A-2	3,000	6,000	9,000	12,000	15,000	6,000
N	UHF Receiver	B-1	630	1,260	1,890	6,300	6,600	1,260
1 / chan	Duplexer	C	345	690	1,035	1,035	1,725	690
1 / chan	Receiver Voting SystemS		2,000	-	2,000	5,500	10,000	-
1	Antenna Tower	T	$33/foot	4,950	3,960	14,775	7,260	1,000
N	Antenna	D-2 or D-3	160	320	480	960	960	320
1/satellite group	Receiver Ant. Coupler	V-1	385	-	-	1,155	1,540	-
1	Remote Emerg. Power	R	2,500	2,500	2,500	2,500	7,500	2,500
N	Equipment Enclosures	AA	200	400	400	400	1,000	200
200'	Transmission Line	L	$3/foot	900	1,260	2,778	3,240	960
	Install (10% hardware)			1,207	1,857	3,263	4,757	1,193
	Subtotal Hardware Cost			$ 18,227	$ 24,382	$ 50,666	$ 59,582	$ 14,123
COMM CENTER								
N	TRACIS Terminal	N/A	leased					
1	Multichannel Recorder	O	10,000 - 15,000	10,000	11,000	12,000	5,000*	10,000
N	Control Consoles	U	7,000	7,000	14,000	7,000	7,000	7,000
1	Emerg. Power Source	R	2,500	2,500	2,500	-	-	2,500
N	Phone Patch	X	350	350	700	700	1,050	350
	Personal Port Battery Charger	Y	650	650	650	650	650	650
	Mods to existing consoles	U				2,000	3,000	
	Install (10% of hardware)			2,050	2,885	2,235	1,670	2,050
	Sub Total			$ 22,550	$ 31,735	$ 24,585	$ 18,370	$ 22,550
							* Upgrade	
	Mobiles (w/portable mount)	P-2	1,465	26,370	49,810	58,600	87,900	30,765
	Portables	P-1	1,250	6,250	12,500	7,500	18,750	6,250
	Install 10%			3,262	6,231	6,610	10,665	3,702
	Subtotal			$ 35,882	$ 68,541	$ 72,710	$ 117,315	$ 40,717
OPTIONS								
	Voice Privacy units	W						
	Base		1,000					
	Mobile		600					
	Portable		450					
	Telephone		500					
GRAND TOTAL				$ 76,659	$ 124,658	$ 147,961	$ 195,267	$ 77,390

TABLE 4-19

IMPLEMENTATION PRIORITY FOR UHF SYSTEMS

	Average Age of Existing Base/Mobile	UHF Channels Need	Have	Chan. Short[2]	Age[2]	LB[3]	Adjac. UHF[4]	Priority Score[5]	Proposed Implementation Year
Ames (LB)	Not Provided	1	0	1	0	3	0	4	1977
Bettendorf (HB)	5-10 yrs.(est.)	1	0	1	1	0	2	4	1978
Burlington (HB)	15 yrs/4 yr.	1	0	1	2	0	0	3	1974 *
Cedar Falls (HB)	5 yrs/1-5 yrs.	1	0	1	1	0	2	4	1977
Clinton (LB)	Not provided	1	0	1	0	3	0	4	1977
Ft. Dodge (LB)	1 yr/1-10 yrs.	1	0	1	1	3	0	5	1976
Marshalltown (LB)	Not Provided	1	0	1	0	3	0	4	1977
Muscatine (LB)	15-20 years	1	0	1	3	3	0	7	1975
West Des Moines (HB) (LB)	10 yrs/1-2 yrs. 7 yrs/1 2 yrs.	2	1	1	1	0	2	4	1976
Iowa City (LB)	1 yr/1-12 yrs.	2	0	2	0	3	0	5	1976
Council Bluffs (HB)	5 yrs/1-5 yrs.	3	0						
				3	1	0	2	6	1975
Sioux City (HB)	20 yrs/1-23 yrs.	4	0	4	3	0	0	7	1974*
Cedar Rapids (LB) (Marion)	7-10 yrs/1-20 yrs.	5	0	5	1	3	0	9	1975
Dubuque (HB)	12 yrs/1-12 yrs.	2	0	2	2	0	0	4	1978

* Special Early Implementation.

1. Channel Short = number
2. Age 1-5 yrs = 0
   5-10 yrs = 1
   10-15 yrs = 2
   over 15 yrs = 3
3. Low-Band = 3
4. Adjacent to UHF city = 2
5. Ratings: High Score = High Priority

TABLE 4-20 BUDGETARY COST ESTIMATES FOR EQUIPMENT-SUMMARY BY YEAR

	1974*	Cost Adjusted for Inflation 1.0	1975*	Inflation Factor 1.07	1976*	Inflation Factor 1.14	1977*	Inflation Factor 1.21	1978*	Inflation Factor 1.28
TACTICAL/INFO										
1974 - Regions: 1,2,6,7 Co: 86,79,48,52, 6, 57	1,481,350	1,481,350								
1975 - Regions: 10,11,5 Co: 66,34,28 Regions: 29,30 Co: 58,92,68,4 Regions: 17,26 Co: 31,49,70			1,867,050	1,997,744						
1976 - Region: 32 Co: 2,87,1,15,78 Region: 13 Co: 5,39,43,83,67 Region: 14,20,21,22 Co: 64,50,59,93 20,27,80,88					1,976,100	2,252,754				
1977 - Region: 3,8,9 Co: 17,98							628,050	759,940		
HB PORTABLES	114,803	114,803	525,448	562,229	571,450	651,453	394,811	477,721	142,804	182,789
Ops LB	96,212	96,212								
Ops HB	89,100	89,100								
UHF										
1974 - Sioux City, Burlington	181,686	181,686								
1975 - Muscatine, Council Bluffs, Cedar Rapids			370,420	396,349						
1976 - Ft. Dodge, Iowa City, West Des Moines					204,882	233,565				
1977 - Ames, Clinton, Marshalltown							193,393	234,006		
1978 - Bettendorf, Dubuque									126,269	161,624
Total by Year		1,963,151		2,956,322		3,137,772		1,471,667		344,413
GRAND TOTAL										9,873.32

* Costs of years implementation based on uninflated late 1973 list prices

5.0 SYSTEM MAINTENANCE

This section is responsive to the maintenance portion of Task 15 delineated in the Scope

The communications systems developed by this plan are designed in accordance with criteria to provide operational performance which meets or exceeds a specified grade of service. Performance tests conducted after installation will prove that the system initially provides this grade of service. Its performance will slowly deteriorate unless regular checks are made to assure that each piece of equipment in the system is operating according to the manufacturer's specifications. This may be overcome by providing regular preventive maintenance through the electronics maintenance facilities of a private service agency or a public agency.

Most of the large municipalities in the state have one or more reliable and competent private business service organizations which will maintain a communications system on such a contract basis. There are, however, some less populous areas of the state where this is not always true. As a consequence, the possibility of an existing government agency providing electronic maintenance has been considered, since two state organizations currently operate several maintenance centers throughout the state. It must be remembered, however, that each agency has a primary responsibility for maintaining its own equipment and a law enforcement agency would not necessarily be assured of receiving electronic maintenance when needed.

A discussion was initiated with Mr. Bill M. Mc Call, Division of Central Services, Iowa Highway Commission in Ames. Mr. Mc Call advised that he would be interested in <u>discussing the possibility</u> of performing such electronic maintenance with the concerned state officials since the Highway commission has nine (9) maintenance centers located in the state from which the radio equipment of highway maintenance vehicles are now repaired.

The possibility of communication system maintenance for law enforcement agencies was also discussed with Major Jack Beaman, IHPR, who advised that such activity by the present Department of Public Safety maintenance facilities is in conflict with the priorities of the department and is not a part of the Iowa Code and, therefore, is not included in the budget.

Most electronics maintenance is performed upon detection of a malfunction of the equipment and/or an observed degradation in system performance. However, such incidents are reduced through the use of preventive maintenance.

Preventive maintenance performed on a regular (six month) basis is shown to be cost effective and provides a more reliable system. For example, an average annual maintenance contract on mobile radio equipment is approximately $84.00 per mobile. This includes time and materials and under a service contract of this type all the communication equipment in a system is checked, adjusted, and/or repaired each six months to assure that its performance is in accordance with the manufacturer's specifications. If a unit fails at any time during the period of the contract, it is repaired and placed back in service immediately or within the time specified. Some service contracts specify a two hour response time beginning with the failure report to the maintenance company. Thus, the user agency is assured his communications system will be fully functioning almost 100% of the time. Furthermore, the operating agency can predict the communications maintenance cost per year. Thereby allowing a budget for this service.

If the electronic maintenance is established for a communications system on an "as needed" (time plus materials) basis, where a service company responds only when a failure occurs, the operating agency cannot be assured of the time in which a repair will be made. This results from the fact that the service companies will handle equipment failures on their service contracts as first priority. Discussions with three (3) major electronic maintenance companies in Iowa reveal that the number of failures per year in mobiles ranges between three (3) and eight (8) with an average of between five (5) and six (6). Labor costs vary from $12 to $20 per hour (depending on location in the state) with additional mileage and time charges if a repair vehicle must travel to a specified location. A minimum time charge is usually specified. Thus, depending on the situation, the annual time and material costs can easily approach or exceed the service contract costs without assurance of expeditious maintenance. Additionally, as a unit ages, the average failure rate per unit will increase. Therefore, it is more difficult to budget for annual maintenance costs under these conditions.

Electronic maintenance for law enforcement and other public safety communications equipment throughout the State is usually performed under a contract with a privately operated business who specialize in this type of service.

The requirements for an overall preventive maintenance program on a communications system are detailed below.

5.1 COMMUNICATIONS SYSTEM MAINTENANCE CONTRACT

Any contract written by a local government for the maintenance of a communications system, should include the following conditions:

1. The contractor and/or his maintenance personnel must each possess an FCC First or Second Class Radio Telephone License,
2. A provision for immediate repair of base station equipment and a maximum repair time of 24 hours on other equipment,
3. Periodic maintenance tests as specified in Section 5.3. These must at least comply with annual maintenance tests required by the FCC,
4. Statement of charges on an hourly or monthly basis and a list of the equipment to be maintained and tested,
5. A statement that all equipment will be maintained in an operational condition which is in compliance with the manufacturer's specifications,
6. A requirement for a specified amount of liability insurance if considered necessary by legal counsel,

7. A requirement for bonding for damages if considered necessary by legal counsel,
8. Requirements for test equipment calibration as specified in Section 5.6,
9. Repairs performed must be substantiated by a trouble report received from the Comm Center Director.

5.2 MAINTENANCE PERIOD AND RECORDS

The recommended maintenance schedule periods that should be observed for the several types of equipment are as follows:

1. Base or remote base station equipment - every six (6)
2. Mobile equipment - every six (6) months in the vehicle and full bench test whenever the unit is transferred from one vehicle to another or maintained for other reasons,
3. Portable equipment - every six (6) months,
4. Base or remote base station emergency power generator operation at full load - once per week (an agency responsibility).

A maintenance log for each piece of equipment listed in the contract should be maintained by the performing service organization. This log should record all repairs, adjustments and/or measurements made on that particular equipment with the date and signature of the individual performing them.

Every law enforcement agency should have a communications equipment trouble report form with which an officer or dispatcher details a problem to initiate remedial action.

5.3 MAINTENANCE TESTS

The following maintenance tests should be performed as provided in the contract on the several types of equipment per applicable EIA specifications and the manufacturer's specification limits:

1. Transmitter (s)
   - a. Power output *
   - b. Standing wave ratio
   - c. Output frequency *
   - d. Tuning adjustment of the several tuned circuits
   - e. Deviation due to standard audio frequency (e.g. 1000 Hz) at fixed amplitude.
   - f. Peak deviation due to voice modulation ($\pm$ 5 kHz peak) *
   - g. Deviation due to CTCS tone modulation (if used) *
   - i. Spurious frequencies only when trouble is reported which indicates the necessity of these tests,

2. Receiver (s)
   - a. Sensitivity - SINAD/12 dB
   - b. Squelch sensitivity
   - c. I.F. passband selectivity and alignment
   - d. Tuning adjustment of the several tuned circuits
   - e. Audio output with standard resistive load
   - f. Frequency of operation
   - g. CTCS operation (if used)
   - h. Spurious frequencies only when trouble is reported which indicates the necessity of these tests,

3. Duplexers and Filters
   - a. Signal rejection during simultaneous transmission or reception (part of system operational tests)
   - b. Tuning **

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* Measurements required at least annually on all transmitters with a power input to the final amplifier greater than 3 watts. FCC Rules and Regulations, Part 89.115.

** Not required unless spurious or intermodulation products are reported or insertion loss is large.

c. Insertion loss
d. Connectors,

4. Control Circuits
   a. All function properly
   b. Operation and distortion of compression amplifiers and expanders (to be checked only if performance is impaired);

5. Batteries - Personal Portable
   a. Battery condition test discharge and recharge when duty cycle is reported as less than the nominal specified
   b. Battery charger operation.

5.4 MAINTENANCE - SPECIAL

Inspection and maintenance of the following items are not usually covered by the preventive maintenance contract.

1. Emergency Generator
   Checking the operation of this unit once a week is normally an agency responsibility.
   a. Starting
   b. Output voltage
   c. Output power
   c. Frequency of output voltage

2. Visual Inspection of Antennas, Towers and Transmission Lines
   A separate contract is usually issued to a tower company for this inspection which should be accomplished annually. If the tower has lights, it is the duty-operator's responsibility as per FCC Rules and Regulations, to determine that the lights have been turned on. Immediate replacement of burned out tower lights must be provided by the agency.

   Such an inspection contract should include:

a. Visual inspection of antenna (with field glasses for broken or misshapen elements, vertical alignment, etc.)

b. Visual inspection of antenna (close inspection, climb tower, etc. performed if system performance is poor and all other equipment performance has been thoroughly checked).

c. Visual inspection of general condition of tower, guys and anchors, and tower section holds and fasteners.

d. Visual inspection of transmission lines (s), jackets, clamps, and connectors.

5.5 MAINTENANCE EQUIPMENT

1. Test Equipment Required:

   a. RF wattmeter, forward and reflected power
   b. Deviation meter
   c. Frequency meter or counter
   d. FM signal generator with individually settable frequency digits and a variable attenuator adjustable down to 0.1 microvolts
   e. High-impedance voltmeter
   f. Multimeter
   g. R. F. voltmeter
   h. Bench power supplies (must be a type which is approved by the radio equipment manufacturer),

2. Other Maintenance Tools:

   a. Electronic technical hand tools
   b. Solder sucker
   c. 30 watt (maximum) solder iron with small replaceable tips
   d. 5 minute Epoxy.

5.6 EQUIPMENT REPAIR (DOWNTIME)

Maintenance contracts should specify immediate repair of base station equipment and a maximum repair time of 24 hours for the other equipment. This means that the contractor's repair facilities must maintain a spare parts stock consistent with the types and quantities of equipment which must be serviced.

5.7 CALIBRATION OF TEST EQUIPMENT

Every maintenance contract should specify that the test equipment used by the contractor must be calibrated and checked against an independently calibrated standard at least once a year. An exception is that the frequency standard or calibration of the frequency measuring instrument must be calibrated against WWV at least every six (6) months.

6.0 COMMUNICATIONS OPERATING PROCEDURES

This section is responsive to Task 19 of the Scope of Work.

The operation of a Public Safety Communications System requires that the Comm Center dispatchers maintain system discipline by following specified functional operational procedures. A list of recommended procedures is given below. This list should not be considered complete or all inclusive, since each operational system may find it desireable to add or delete items for use in their operations.

1. Radio Voice Circuits (General):
   a. Observe all applicable FCC Rules and Regulations, Parts 89.151-89.179 and 89.303- 89.305
   b. Use standard signals (as specified by the agency)
      1. APCO 10-signals (latest version)
      2. Phonetic alphabet (Reference 18)
      3. Special codes (coordinate state-wide usage via APCO or Advisory Committee)
      4. Time of day state-wide (Reference 18)
      5. Standardized law enforcement abbreviations (Reference 18)
   c. Use standard terminology and phrasing. (Reference 18)
   d. Give information in a standard or specified format, e.g. description of person (Reference 18) or vehicle (CYMBAL), (Color, year, make, body, and license).
   e. At a base station, use the proper and correct voice communication techniques for that location. (Reference 18, Section A 3.0)
   f. In a mobile unit use the proper and correct voice communications techniques for that situation (Reference 19, Section B 3.0)
   g. In relaying a message, repeat wording exactly as received
   h. Use speech scramblers on a non-routine basis and only when security is required on a short term basis
   i. Answer all calls within 15 seconds
   j. Speak clearly and distinctly and do not slur words
   k. Record actions and time stamp data card
   l. Keep an up-to-date record of the status and location of the several officers using mobile vehicle or portable units and follow up inquiry in reasonable time on out-of-service vehicles especially in com-

promising situations.

m. At regular intervals, weekly or monthly, record in the Comm Center log the number of transmissions and total channel occupancy time as indicated by the console counters,

2. Radio Voice Circuits (Specific Channels):

a. Operational Channel - F-1 High-Band or Low-Band

The radio frequency and subaudible tone code (CTCS) for this channel varies from region to region (See Volume I, Section 1.3 and Table 2-1).

This channel is used for routine administrative, dispatch and operations; base-to-mobile, mobile-to-base, and mobile-to-mobile communications. The Operations Channel will be routinely selected on the mobile radio control head (a signal on the Tactical Channel is automatically sensed irrespective of which of the other three (3) channels is selected).

The use of all "10-signals" and other operational codes is permitted on this channel.

b. Information Channel - F-2

The radio frequency and the sub-audible tone code (CTCS) used for this channel varies from region to region (See Volume I Section 1.3 and Table 2-1).

Under normal or ordinary conditions this channel will be used within a given region for communications from base-to-mobile and mobile-to-base related to:

1. Vehicle registration
2. Vehicle license plate checks
3. Stolen vehicles
4. Wanted persons
5. Warrants
6. Any request which requires obtaining information from a micro-film or computer based data system.
7. Stolen property (serial numbered)

Digital data transmissions will use this channel when county or non-UHF cities employ such data systems. Data and voice may be interspersed with the usual care at point of dispatch.

In the mobile, this channel will be selected only when a call is transmitted or when a call is expected.

One way selective calling of special squad members via tone or voice messages will use this channel.

The use of all "10-signals" and other operational codes is recommended for this channel,

c. Wide-Area Channel - F-3

The radio frequency and sub-audible tone code (CTCS) used for this channel varies from region to region (See Volume I, Section 1.3 and Table 2-1).

The basic operation of this channel is a repeater function, i.e. the information received on one frequency is re-broadcast on a different frequency.

This channel is used for long-range mobile-to-mobile (either intra-agency or inter-agency) communications or local agency mobile-to-IHPR when authorized by the local Comm Center. It must <u>not</u> be used for short-range mobile-to-mobile communications (See Operational Channel) because of the large number of mobiles potentially requiring service within a region. In the mobile the Wide-Area Channel will be selected only when a call is transmitted or when a call is expected.

Communications on this channel will primarily involve non-emergency coordination of activities between agency or cooperating agency mobiles. It is recommended that cooperative rules and procedures be established for <u>state-wide</u> use by Communications Advisory Committee action compatible with IHPR and local agency usage.

d. 'Iowa Tactical Channel - F-4 (National Mutual Aid Frequency 155.475 MHz, no sub-audible tone code, CTCS).

The use of this channel must be carefully regulated by Advisory Committee action with Public Safety approval and limited to communications as follows:

The state-wide common emergency frequency shall be used primarily for emergency communications between police agencies, and in cooperation with ambulances. For the purposes of this rule, the term "emergency" means a set of circumstances resulting from natural disaster, accident, civil disorder, national emergency, or criminal activity which requires coordination and cooperation between various police agencies to protect lives or property. Routine inter-agency exchanges of information and communications regarding activity where life or property are not immediately endangered are not emergency communications for purposes of this rule. The common emergency channel may be used on a secondary basis to provide communications to any itinerant police vehicle or ambulance when said vehicle is beyond communication range of its base station and when no other communication medium is readily available. This secondary use shall not cause harmful interference to the primary use of the channel.

It is recommended that the use of "10 signals" on this channel be limited to 10-4, 10-30, 10-33, and 10-78 (with appropriate code modifier or verbal description.),

3. Telephone Circuits
   a. Answer all emergency request calls within 15 seconds (before the third ring)
   b. Speak clearly and distinctly and do not slur words.
   c. Request the data needed to respond to the indicated type of emergency.
   d. Enter data on a standard form provided.
   e. Time stamp data card when request information has been completed.
   f. Transfer data card to radio console if separate from telephone console.
   g.
   h.

   log the number of emergency requests received and the number requiring more than 15 seconds response time,

4. Teleprinter Circuit

The Comm Center teleprinter(s) may be connected to one or more law enforcement communication or computer networks, i.e., TRACIS, LETS, LENCIR, NCIC, etc. When operating the teleprinter in one of these networks:

a. Use the address procedure required.
b. Wait for the correspondent or the system computer to answer.
c. Use the message format required for that network.
d. If the message is more than two or three lines, use pre-punched tape and the tape reader to transmit the message.
e. Do not allow the teleprinter to idle on the circuit while obtaining information from another source,

5. Physical Operations

a. Do not leave the Comm Center unattended.
b. Do not allow entry to unauthorized individuals.
c. Require idenfication of all individuals requesting entry to the Comm Center.
d. Transfer incoming or outgoing data recorded on paper (teleprinter, reports, etc.) through a "report slot" to personnel not authorized to enter the Comm Center.

7.0 SYSTEM MANAGEMENT

This section is responsive to the general requirement as stated in Section 2.2.8. It is intended that the provisions of this section indicate the manner in which the communications system management should be organized, policies which should be developed and the personnel selection guidelines , personnel job descriptions and job specifications and training guidelines which are necessary to establish consistent personnel management procedures.

Reference information was gathered at the program outset, consisting of Iowa merit job descriptions of the various departments' communications personnel. These did not provide a consistent treatment or the specific job descriptions for Comm Center personnel at the local level. A consistent treatment of job specifications, descriptions, and personnel selection guidelines was needed based upon a professional development by consultants experienced in this work.

Accordingly, Spectra Associates approached Batten, Batten, Hudson and Swab of Des Moines, who are internationally recognized for their management consultation, personnel selection, and personnel motivation training. It was quickly recognized that a team effort was desirable in developing the required material. A subcontract was issued to BBH and S to achieve this end.

Results of this effort in the following paragraphs provide management, training, and personnel selection guidelines beyond anything known to exist in law enforcement Communications Center management. It is believed their usage will promote an extensive increase in the efficiency and quality of performance in Comm Center operation consistent with the upgrade in system hardware operations.

7.1 COMM CENTER GOVERNING BOARD

Management of a county-wide or a multi-county law enforcement Comm Center is important to ensure that center operations policies are established and that operations are conducted in a professionally competent manner, consistent with recognized standards and in keeping with the requirements of all user agencies.

The achievement of this management function requires a Communications Governing Board to provide an effective management method which can provide a professionally integrated dispatch operation. The Board is responsible to all law enforcement and public safety using agencies. These agencies vest their responsibility to this Board for communication of complaint response and dispatch control to their officers. Development of this Governing Board is consistent with and conforms to Iowa Code, Chapter 28E and specifically 28E.4, 28E.5 and 28E.6.

It is recommended that:

1. A Communications Governing Board of approximately eleven (11) members should be established as soon as it is determined that this plan will be implemented. The agreement of organization shall be drawn to include specifications as indicated in Iowa Code 28E.5,
2. The election or appointment of Board members should assure representation of all user agencies or groups of agencies from within the county or from a group of counties (region). (See the suggested agency representation lists). Each represented agency shall take approval action and authorize their participation in accordance with Iowa Code 28E 4.
3. An agency representative member should be appointed by the agency management on the basis of his knowledge and experience in law enforcement communications and may be an individual now repsonsible for the present agency communications supervision and operations functions.

Suitable representation would be gained for each county or region board when each of the following agencies or groups of agencies appointed a representative: by whom?

County Sheriff
County Seat and Major Community Police Departments
County Civil Defense Director
County Seat Fire Department (ex officio)
Other public Safety Agencies (ex officio)

Responsibilities of the Communications Governing Boards include at least the following areas of activity:

1. Determine the facility in which the Comm Center will locate to provide adequate space, working conditions and physical security,
2. Determine the degree of participation desired by all cooperating agencies,
3. Prepare or contract preparation of the specific requirements for the county-wide communications system:
   a) Radio base station elements,
   b) Telephone, both emergency request, inter-agency (outgoing/incoming) and administration,
   c) Mobile and portable radio units,
   d) Data system (TRACIS, LETS, county information system, etc.),
4. Select either a suitable antenna tower site or determine the suitability of the present tower and site,
5. a) Prepare the system implementation grant for the county law enforcement communications system,
   b) Provide purchasing policies and oversee procurement for the communications system after approval has been granted by funding authorities,
6. a) Provide the impetus for preparation of applications for the official APCO frequency coordination and FCC license changes,
   b) Provide assurance that FCC license renewals are current for each associated facility,
7. Develop policies for center operations, funding and maintenance cost proration to the user agencies,

8. Use guidelines for selection, conduct interviews, evaluate and employ a Communications Center Director.
9. Develop policies for dispatch procedures, records development/usage:
   a) Message priorities, all agencies,
   b) Network discipline,
   c) Use of procedural codes,
   d) Message security devices,
   e) Log keeping
   f) Record retention,
   g) Reports to individual agencies,
   h) Evaluation of emergency response time, dispatch action response time and other performance evaluation,
10. Utilize dispatcher job descriptions, selection and evaluation guidelines and assure the Comm Center Director is following those in developing and maintaining a capable dispatcher staff. This volume contains a set of recommended guidelines for these,
11. Develop a policy for training of all dispatchers and officers in the dispatch procedures and network discipline. Volume II has in it a list of training guidelines.
12. Develop system maintenance policies and performance evaluation for assuring equipment reliability. This can be via in-house maintenance or contract maintenance technicians,
13. Maintain a planning function for development of the county system implementation at a functional level which meets the growing requirements of the communities and agencies served by the center.
14. Maintain a working relationship to the state Communications Law Enforcement Advisory Committee.

The Governing Board of each Comm Center must hire a director for their center. Job specifications and descriptions for the director position and that of center personnel are provided in Section 7.3 of this report.

7.2 COMMUNICATIONS CENTER ORGANIZATION

The proposed organization for Comm Center operations utilizes a Governing Board, a Comm Center director, shift communications supervisors, and dispatchers/operators to provide user agency control. The relationship of these organizations and individuals is shown in Figure 7-1. The size of the center and the geographical area involved, along with the total responsibility, will determine the need for and practicality of having three or more organizational levels.

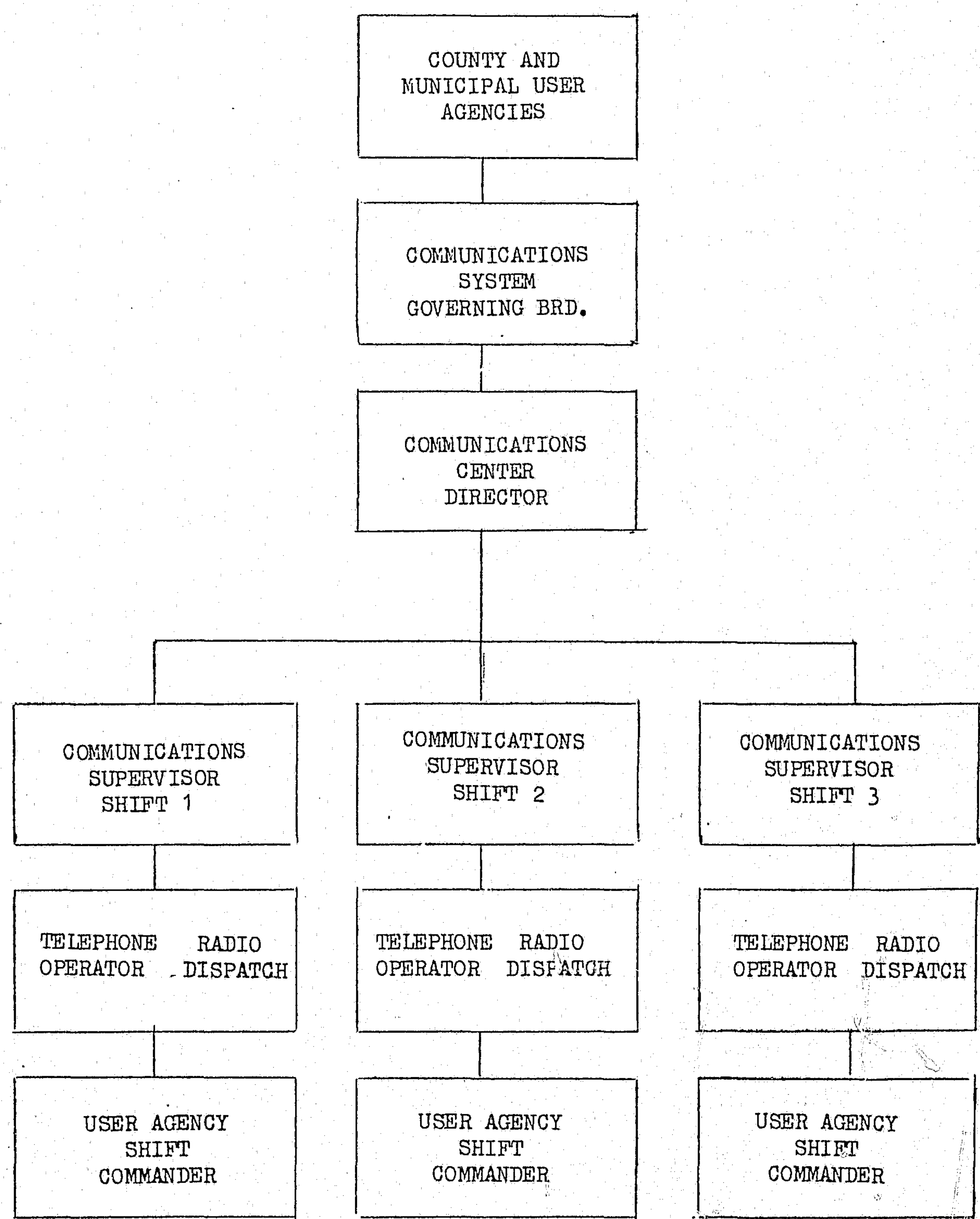
In smaller Communications Centers budgetary limitations coupled with the lesser demand for sophisticated personnel staffing may eliminate the supervisory level between the Center Director and the operators.

Civilian communications operators should have immediate access to a uniformed law officer with adequate authority in those emergency situations when there is a need for aid and assistance. Some law enforcement departments may not consider it necessary to have a uniformed shift sergeant at the Communications Center at all times.

Communications Center operations should be carried out on a twenty-four hour basis consisting of three (3) shifts of basically eight (8) hours each. The shift changes should avoid peak traffic load periods. Consequently, a much smoother carry-over and exchange of information can be made between departing and entering personnel.

Center operations may be established on either a rotating shift or permanent shift basis. Some law enforcement organizations now prefer the permanent or fixed-shift system because of the reduction in physical and emotional frustrations experienced by personnel in being required to periodically change their entire living pattern produced by the rotating shift operations. Not only does the preparation of rotating shift working schedules become frustrating, but individuals must frequently and continually adjust their daily living patterns to conform with the ensuing working schedule.

Figure 7-1 COMMUNICATIONS SYSTEM ORGANIZATIONAL CHART



It is recommended that shift personnel be assigned on the basis of a fixed shift unless Comm Center management and personnel agree that the rotating shift is desirable.

Communications Center operating policies, procedures, practices, guidelines, etc. should be assembled in an orderly fashion and made a matter of record through appropriate documentation. Operating manuals, organization charts, job descriptions and other related management and supervisory aids and tools should also be available at all Comm Centers for reference of supervisors and personnel.

7.3 PERSONNEL JOB SPECIFICATIONS, DESCRIPTION AND SELECTION

The need for highly capable and experienced communications operator personnel takes precedence over their law-enforcement experience and capability. There is a preference for the professional communications person who is high capable and experienced, but may be lacking experience in police work or relat law enforcement, as compared with the person with law enforcement experience having only mediocre experience and capability as a communications operator.

The future professionalism and high standards of excellence and effectiveness of the communications system operation depends upon its personnel as well as its hardware and equipment. This high degree of professionalism will be dependent upon individual loyalty, dedication, initiative, a sense of responsibility, and such objective qualities as the ability to accurately spell and type, write legibly, to accurately utilize basic arithmetic and ma tain personal cleanliness and grooming.

The professional operator is a highly capable person who possesses excellent physical, emotional and mental health. Effective function requires a high level of stability in all three areas and performance as a communications operator is largely determined on that basis. The operator who loses control of his emotions while on the air immediately loses his effectiveness and his rapport with mobile unit operators. Center operators who are the most effect in providing communications have an understanding of the officers' operating conditions, problems and desires and on occasion spend some of their off-duty time riding with an officer. This further enables individuals to become better acquainted and to exchange information concerning each person's job, its requirements, peculiarities and challenges.

A definite need exists for more intensive and thorough training of Comm Center personnel, particularly operators. Many operators presently receive virtually no training, some perhaps two hours at the most. The proposed civilian radio operators curriculum developed by the Iowa Law Enforcement Academy in conjunction with the Iowa Department of Public Safety is an initial effort to cope with the existing training needs. Reference 20. Section 7.4 provides a listing of desired areas of training for further consideration. When implemented, this program will consititute a significant and needed step forward. A state-wide training program available to local Comm Center communications personnel is planned for the coming fiscal year. The employment of communications operators should be contingent upon their ability to successfully complete this course or its equivalent. Eventually, certification of successful graduation will become a mark of the professional stature of the communicator.

7.3.1 COMMUNICATIONS CENTER OPERATIONS - GENERAL

Staffing Goal

Staffing of the Comm Center should be carried out with vision and objectivity. It should be a planned process involving present needs and objectives as well as long-range mission and goals.

A Comm Center may be equipped with the very latest and most sophisticated communications hardware and electronics, but if the quality and professional capability of the personnel who operate the equipment is sub-standard, the entire Comm Center operation will be sub-standard.

The staffing policy of the Comm Center Governing Board should be the recruitment and selection of highly qualified and capable professional communications personnel. Each Comm Center Director should be carefully selected. The effectiveness of the total operation for which he is responsible will largely depend upon the personnel selected for the organization. He should, therefore, play an important role in the total recruitment and selection function of operators.

Recruiting and Selection Guidelines

The Comm Center personnel recruiting objective should be to acquire candidates who are most likely to fit in with the high standards of operational quality, effectiveness and professionalism established by the Governing Board.

Candidates should be able to pass preliminary job-related aptitude tests designed to determine their qualifications for the type of position they are expected to fill. Successfull completion of a certified training course is suggested as a later prerequisite for employment.

The candidate should also be in excellent physical condition as attested to by his personal physician. In addition, the candidate should be willing to undergo a comprehensive physical examination prior to hiring which must include an audiogram (test for hearing). The physical examination should be at least comparable to that required by the FAA for a Private Pilot License.

A comprehensive interview should be given each candidate, preferably by at least two interviewers. The combined evaluations will generally provide somewhat more objective results than if the interview is conducted by only one person.

An objective and meaningful interview and evaluation should encompass such things as: (Descriptives may be checked accordingly)

A. Appearance

1. Immaculate
2. Neat
3. Disheveled
4. Unclean
5. Unshaven
6. Slovenly
7. Other (Specify)

B. Intelligibility

Diction

1. Defects or distraction in voice
2. Chooses words precisely
3. Pronounces words correctly
4. Slurs speech
5. Speaks clearly

6. Lisps or stammers
7. Hard to understand
8. Other (specify)

Fluency

9. Vocabulary adequate
10. Sentence structure clear
11. Uses words correctly
12. Questionable use of slang or colloquialisms
13. Pronounces words correctly
14. Pronounces words too rapidly
15. Other (specify)

Understanding

16. Makes him/herself understood orally
17. Understands others readily
18. Listens to what others say
19. Comments (specify)

C. Attitude (note as applicable)

1. Enthusiastic
2. Friendly
3. Quiet
4. Talkative
5. Discourteous
6. Argumentative
7. Confident
8. Confused
9. Other (specify)

D. Stability (yes or no as applicable)

1. Gets upset easily
2. Seems highly nervous
3. Looses self-control readily
4. Appears self-possessed
5. Reacts strongly when disagreed with
6. Relaxed
7. Tense

E. Perception and Vitality (yes or no as applicable)

1. Slow to understand questions
2. Lets his/her attention wander
3. Is objective
4. Displays sound judgement.

dispatcher and supervisor, he must be able as the Center Director, to think, act and function as a manager. He must be able to see and comprehend the broad picture. He must be able to effectively lead and direct others as together they supply their operational portion of the total picture.

When a candidate being considered for the position of Center Director comes from within the area being served by the Comm Center, the selection process may be facilitated somewhat, in that the candidate's personal history and past performance record is better known. However, he must be able to meet and comply with all of the qualification requirements as set forth in the Position Specification and Description for Center Director.

If the candidate is being brought into the Center from outside the geographical area served by the Center he will likely be an unknown and should, therefore, be screened thoroughly concerning personal and professional background, experience, training and performance. The Comm Center Director Position Specification follows this material.

B. POSITION SPECIFICATION

Position Title: Communications Center Director
Reports To: Governing Board
General Function: The Communications Center Director develops and implements plans, directs and coordinates Communications Center operations, and performs related functions involving administrative, technical and inter-agency relationships. He carries out operational policy as established by the Governing Board.

Responsibilities:
The Communications Center Director is responsible for:

(1) Effective direction and supervision of the Comm Center operations involving all assigned human and technical resources.
(2) Effective integration of all resources and capabilities with those of other agencies and cooperation with such agencies to create a greater degree of excellence in overall law enforcement and public safety.

5. Slow to respond to questions
6. Appears alert and energetic

F. <u>Motivation and Interest (yes or no as applicable)</u>

1. Expresses a positive vocational commitment in radio, telephone and data communications
2. Reasons for desiring this type of vocation are sound
3. Expresses desire for a career that is consistent with the needs of public safety and law enforcement communications.
4. Seems interested in doing a job well
5. Easily discouraged
6. Comments on any other observations considered significant.

An appraisal of the candidate should be based upon a very thorough evaluation of each of the foregoing criteria weighed on the basis of one of the following:

1. Excellent
2. Above average
3. Average
4. Below average
5. Unacceptable

If the final appraisal score averages "unacceptable" or "below average", the reasons for this evaluation should be listed in sufficient detail to become a justifiable matter of record.

7.3.2 CENTER DIRECTOR

A. <u>SELECTION</u>

In building an organization it is generally more advantageous to select from within that organization when filling vacancies. If after all available personnel are considered carefully and their qualifications evaluated as objectively as possible, it is decided that no one quite meets the requirements, a person to fill the position must be acquired from outside the organization.

The Center Director must be a well-qualified person in several ways. Although having perhaps progressed along the operations route as a technician, operator,

(3) Dynamic growth, development and functioning of an efficient Center operation in accordance with sound management and human relations principles.

(4) Operational excellence in complying with and carrying out organizational policy and requirements as established by the Governing Board.

(5) Administrative excellence in developing and implementing center operating policy, procedures and requirements and requiring compliance therewith.

Background:

The Communications Center Director:

(1) Must have had extensive experience in law enforcement and public safety operations.

(2) Should have a comprehensive background of operational experience and knowledge in law enforcement and public safety communications.

(3) Must have practical knowledge, experience and capability involving the supervision of people.

(4) Should be a graduate of an accredited high school and have two (2) years of technical schooling in electronics and communications technology, or possess the equivalent of such background.

(5) Should have a sound professional background consisting of at least three (3) years experience as a radio operator, preferably in law enforcement communication.

(6) Should have a Second Class or higher FCC radio telephone license and a current, valid drivers' license.

Personal Qualifications:

(1) Good health, physical condition and emotional stability. No uncorrected hearing or eyesight impairments.

(2) General maturity to the degree that sound judgment concerning personal organization, management of finances, and family and community relations is exercised.

(3) Good personal living and cleanliness habits, neat appearing, personable and possessing significant leadership qualities.

(4) Good command of the English language from the standpoint of speaking voice, diction and self-expression.

(5) High degree of insight, imagination and originality and the ability to effectively comprehend, assess, coordinate and direct.

(6) Must be able to sustain and successfully pass a comprehensive and thorough personal background investigation.

Salary Information: (As appropriate in the establishment of fair and equitable employment practices for this level of responsibility and competence.)

C. POSITION DESCRIPTION

Position Summary

The Comm Center Director develops and implements plans, directs and coordinates Comm Center operations and performs related functions involving administrative, technical and inter-agency relationships. The Comm Center Director performs under the direction of the Governing Board of the area in which the Comm Center operates.

Principle Duties and Responsibilities

- Insures that the established policy of the Governing Board concerning the Comm Center is professionally and effectively carried out through skillful human and technical resources management.
- Cooperates with the Governing Board and the Purchasing Director in acquiring new equipment and services.
- Administers the expenditure of funds allocated through budgeting provisions.
- Develops operational status reports for the Governing Board and interacts with agencies served by the Comm Center.
- Establishes emergency and disaster mode communications procedure for effectively utilizing human and technical equipment resources.
- Prepares specifications and assists with the planning for purchase of new equipment and the development of new center capabilities.
- Integrates his Center's resource capability with the Civil Defense Communications Plan for the area in which his Center operates.
- Develops and utilizes meaningful procedures for testing the performance of radio equipment.

- Responsible for the effective selection of Comm Center personnel
- Responsible for the effective direction, supervision and general guidance of Comm Center personnel in performing their assigned duties.
- Responsible for preparing the Comm Center budget and presenting the budget to the Governing Board.
- Responsible for the relevant and meaningful training development of all assigned personnel.
- Responsible for installation and maintenance of all communications and electronic equipment and for maintaining an accurate equipment inventory.
- Responsible for maintaining required Federal Communications Commission frequency measurements and related records, license renewals and other related F. C. C. records.
- Responsible for promoting a positive cooperative relationship between center personnel and the agency command and officer personnel served by the center.
- Responsible for providing training and periodic instruction to agency personnel for the purpose of enhancing the effective communications between the Center and cooperating agencies.

Education, Experience and Professional Requirements

Minimum: Graduation from an accredited high school or general education development curriculum and two (2) years of technical schooling in electronics and communications technology.

Minimum: Three (3) years of administrative experience in communications in a major city, county or commercial radio facility, preferably in law enforcement communications.

Optional: Three (3) years, in addition to the above, of experience as a radio operator in a major city, county or commercial radio facility, preferably in law enforcement communications. He may be a uniformed officer.

Knowledge, Ability and Skill

- Must have a thorough knowledge of Federal Communications Commission Rules and Regulations and two-way communications equipment operation and maintenance.
- Ability to effectively plan, direct and coordinate all of the administrative and technical functions of the Comm Center.

- Ability to effectively and meaningfully express ideas, plans, policies, and procedures both orally and in writing.
- Ability to skillfully operate and utilize electronic equipment.
- Ability to deal tactfully, courteously and skillfully with the human relations and other problems which arise involving center personnel, agency law enforcement personnel and their commanders, and the general public in a knowledgeable and effective manner.

Results Expected

Effective administration of the total Comm Center operation so that it will provide accurate, timely, efficient and professional law enforcement and public safety communications and inter-service cooperation at all times.

The Comm Center Director should feel concern and responsibility for the continuing effectiveness of his Center personnel by insuring their continuing training and progress through appropriate aids and assistance both internal and external. He must also remain cognizant of the on-going need for his own personal growth and development.

In addition to the necessary technical and job-related communications knowlege, information, and awareness improvement continually required of him, the Center Director should annually attend developmental programs involving personal and human relationships development and personnel management.

7.3.3 COMMUNICATIONS SUPERVISOR

A. SELECTION

The Communications Supervisor should be a well qualified person technically from the standpoint of communications equipment operations and maintenance and he must also be able to work with and supervise others effectively. His ability to provide the quality leadership and the stabilizing force needed to unify his people will largely determine how well his work group consistently contributes to the total Comm Center effort.

The Communications Supervisor position should be filled from within the organization whenever practical. When a qualified and well-liked person is selected to move into a position of greater responsibility, the espirit-de-corps of the organization is thereby enhanced. Personnel are made aware of the fact that the opportunity for personal growth and advancement does exist within the organization and their turn could come, should they be interested in additional advancement and responsibility.

The person filling this position should be able to work well with persons under his supervision and he must also be able to work well with his superior. Regardless of whether the supervisor is in uniform or a civilian, it is extremely important that effective and meaningful working relationships be established within the Comm Center. In the larger municipalities this position of Communications Supervisor will, in some instances, be held by a uniformed officer such as the shift sergeant. At the state level, the position might be held by a uniformed trooper when the Comm Center operations and the patrol post headquarters are centered in the same location.

B. POSITION SPECIFICATION

Position Title: Communications Supervisor

Reports To: Communication Center Director

General Function: The Communications Supervisor directs and coordinates the Comm Center shift operations providing technical assistance and general supervision involving the effective functioning and maintenance of an established Comm Center engaged in transmitting and receiving of public safety and law enforcement messages by means of radio-telephone, telephone and Teletype.

Responsibilities:

The Communications Supervisor is responsible for:

(1) Effective planning and scheduling of the Comm Center shift operations in fulfillment of the Center's established objectives and overall purpose.

(2) Supervision of assigned personnel in a manner which will effectively contribute to optimum utilization of all available human and technical resources.

(3) Insuring the effective cooperation of the Center's resources with those of other agencies and application of all Center capabilities in a way which will enhance law enforcement and public safety excellence.

(4) General operating efficiency and compliance with established Center operating policy, procedures, regulations and records-keeping requirements,

(5) Contributing to the continued growth, development and functioning of an efficient Center operation through the utilization of sound management and human relations principles.

Background:

The Communications Supervisor:

(1) Must have had extensive experience in law enforcement or public safety operations. To have had experience in both areas would be a distinct advantage,

(2) Should have a comprehensive background of operational experience and a working knowledge of law enforcement or public safety communications, preferably both,

(3) Must have practical knowledge, experience and capability involving the on-line supervision of people,

(4) Should be a graduate of an accredited high school and have three (3) years of professional experience as a competent radio operator or the equivalent of education and experience,

(5) Should have a Second Class or higher radio-telephone license as issued by the Federal Communications Commission.

Personal Qualifications:

(1) Good health, physical condition and emotional stability. No uncorrected hearing or eyesight impairment,

(2) General maturity to the degree that sound judgment concerning personal organization, management of finances, and family and community relations is exercised,

(3) Good personal living and cleanliness habits, neat appearing, personable and possessing significant leadership qualities,

(4) Above average command of the English language from the standpoint of self-expression, good handwriting, spelling, speaking voice and diction,

(5) Insight, imagination, originality and the ability to accurately comprehend, assess, coordinate, and effectively direct ,

(6) Must be able to sustain and successfully pass a comprehensive and thorough personal background security investigation.

Salary Information: (As appropriate in the establishment of fair and equitable employment practices for this level of responsibility and competence

C. POSITION DESCRIPTION

Position Summary

The Communications Supervisor directs and coordinates the Comm Center shift operations providing technical assistance and general supervision involving the effective functioning and maintenance of an established Comm Center engaged in the transmitting and receiving of public safety and law enforcement messages by means of radio-telephone, telephone and Teletype. The Communications Supervisor performs under the general direction of the Comm Center Director.

Principle Duties and Responsibilities

- Plans and schedules the shift work of the communications operators so that it will effectively achieve the established objectives and purpose of the Communications Center.
- Supervises assigned personnel in a manner which will effectively contribute to optimum utilization of all available technical and human resources.
- Provides guidance and counsel to personnel in interpreting communications policy, procedures, codes and standards.
- Provides assistance in conducting the personnel selection and placement process for the center.
- Assists with the personnel training and development process as appropriate and evaluates employee performance at periodic intervals.
- Participates in staff conferences, seminars and training sessions.
- Maintains personnel work records, requisitions parts and supplies, and controls unit expenditures.
- Responsible for maintaining an operations record system including the center log for message and incident recording.
- Responsible for general care and maintenance of Comm Center area.

- Responsible for maintaining statistics concerning center operations and periodically summarizing the information into reports for the Center Director.
- Responsible for the general maintenance and repair of Comm Center transmitting and receiving equipment.

Education, Experience and Professional Requirements

Minimum: Graduation from an accredited high school or general education development curriculum and three (3) years of experience as a radio operator in a city, county, state, commercial or industrial radio facility, and possession of a Second Class radio-telephone license; or two (2) years of the required experience and possession of a First Class radio-telephone license as issued by the Federal Communications Commission; or an equivalent combination of education and experience.

Special Requirements: Ability to pass a background security investigation to include fingerprinting.

Knowledge, Ability and Skill

- Must have a thorough knowledge of Federal Communications Commission Rules and Regulations.
- Must have a thorough working knowledge of two-way radio communication operations and procedures.
- Must possess extensive knowledge of communications equipment and technical maintenance techniques and procedures.
- Ability to effectively plan, direct and coordinate the required administrative and technical functions occurring on any shift of the Comm Center operations.
- Ability to effectively and meaningfully express thoughts, policies, and procedures, both orally and in writing.
- Ability to function rationally and unemotionally when confronted with emergency situations.
- Ability to skillfully operate and utilize electronic equipment.
- Ability to deal skillfully, courteously and tactfully with the human relations situations and other problems which arise involving center personnel, agency law enforcement and public safety personnel and their commanders, and the general public in a knowledgeable and effective manner.

Results Expected

- Effective supervision of Comm Center shift personnel so that they will provide accurate, timely, efficient and professional law enforcement and public safety communications and inter-service cooperation on the shift operation for which responsible.

In order to provide continuity in maintaining the desired standards of quality, effectiveness and professionalism established by the Governing Boards, the supervisor should successfully complete an equivalent of the Civilian Radio Operators School conducted by the Iowa Law Enforcement Academy as approved by the Iowa Department of Public Safety.

The Comm Center Supervisor should, at least annually, attend a course of instruction involving personal and human relations development and personnel management. As a supervisor of others, the basic knowledge and understanding of how to work with people can enhance the effectiveness of the Comm Center Supervisor.

7.3.4 COMMUNICATIONS OPERATOR

A. SELECTION

The Communications Operator should be thoroughly screened and carefully selected person highly skilled in his profession. His superior performance arises from devotion to duty and the determination to fulfill assigned responsibility. He must be selected on the basis of his acceptance of responsibility to fulfill the requirements of his position. This includes the prompt, accurate and courteous handling of communications in a professional manner resulting in the utmost assistance to law enforcement and public safety agencies and personnel. His effectivenss will be in direct relation to his initiative and sense of responsibility.

The Communications Operator position must be filled by a highly qualified person who, in extreme emergencies or disaster, when traffic multiplies due to additional personnel and the requirements of inter-service coordination, when emotions run high and when success seems impossible, can bring order out of chaos by analyzing the message traffic he hears and suggesting the best utilization of the resources which he knows are available.

The person selected to fill this position must be a calm, courteous and alert professional who knows the capabilities and limitations of the communications system that he is authorized to operate. He must be familiar with the administrative organization, its resources and equipment, and assigned duties both regular and emergency. He must be knowledgeable with regard to law enforcement practices and organization and communications capabilities of cooperating agencies. He must also be able to determine which Federal Communications Commission Rules and Regulations are applicable. The Communications Operator Position Specification follows this material.

B. POSITION SPECIFICATION

Position Title: Communications Operator*

Reports To: Communications Supervisor

General Function: The Communications Operator transmits and receives public safety and law enforcement messages and monitors communications between safety and lay enforcement agencies and mobile units. Performs related duties and functions as appropriate.

Responsibilities:

The Communications Operator is responsible for:

(1) Receiving and transmitting messages between the Comm Center and other state, county, and municipal public safety and law enforcement authorities or operations.

(2) Monitoring public safety and law enforcement communications and relaying messages to other centers or mobile units as appropriate.

*The position of Communications Operator should be separated into three (3) separated and distinct levels (e.g. Comm Operator A, B, and C) according to experience and training, etc.

(3) Effectively responding to the need for accurate information and reporting in emergency situations and coordinating available human resource effort and technical equipment as appropriate.

(4) Obtaining confidential criminal and public safety information and records from the state and national crime information system sources for appropriate dissemination and enters information into the system as necessary.

(5) Compiling public safety and law enforcement information and reports for future reference and dissemination.

Background:

The Communications Operator:

(1) Need not have had extencive experience in both law enforcement and public safety communications operations. Should have experience in one or the other, however.

(2) Should have a comprehensive background of operational experience and a practical working knowledge of two-way radio communications procedure and equipment, preferably in connection with either law enforcement or public safety operations.

(3) Must have a working knowledge of basic office procedure, including filing systems, records keeping and control.

(4) Should be a graduate of an accredited high school or general educational development curriculum, or possess an appropriate combination of equivalent education and experience.

(5) Should have a Third Class or higher radio-telephone license as issued by the Federal Communications Commission.

Personal Qualifications:

(1) Excellent health, physical condition and emotional stability. No uncorrected hearing or eyesight impairment. Ability to pass audiogram (hearing test).

(2) General maturity to the degree that sound judgment concerning personal organization, management of finances and family and community relations is exercised.

(3) Good personal living and cleanliness habits, personable and possessing strong leadership qualities.

(4) Above average command of the English language, excellent speaking voice and diction, legible handwriting, good basic arithmetic and spelling and ability to accurately type 20 words per minute (minimum).

(5) Capability for effective thinking and acting in emergency situations and functioning with speed, accuracy and emotional self-control.

(6) Willingness and ability to work irregular shift assignments under confining circumstances.

(7) Must be able to sustain and successfully pass a comprehensive and thorough personal background security investigation.

Salary Information: (As appropriate in the establishment of fair and equitable employment practices for this level of responsibility and competence.)

C. POSITION DESCRIPTION

Position Summary

The Communications Operator transmits and receives public safety and law enforcement messages and monitors communications between the Comm Center and other local agencies and between other public safety and law enforcement agencies and mobile units. The Communications Operator responds to emergency situations as appropriate and performs related functional requirements with accuracy and effectiveness, working under the direction of the Communications Supervisor.

Principle Duties and Responsibilities

- Receives, transmits and monitors messages from or between the Communications Center, the public and other state, county, and municipal public safety and law enforcement authorities through telephone, radio-telephone and Teletype communication and dispatches or relays messages to other Comm Centers.
- Obtains confidential criminal and public safety information and records from the state and national crime information sources for state, county and local law enforcement officers and enters such information into the system as appropriate.

- Compiles information concerning stolen cars or property, persons wanted for crimes, runaway persons and similar crime or public safety involvement.
- Monitors radio channels at all times for communication indicating impending danger to law enforcement or other public safety personnel for the others and providing guidance and assistance as appropriate.
- Queries telephone callers to accurately determine the assistance needed, location and kind of accident or incident and promptly notifies law enforcement officials and dispatches emergency vehicles as appropriate.
- Informs the news services of accident information or law enforcement activities which have been cleared for release.
- Provides current weather information to public safety and law enforcement personnel and the public.
- Maintains a typewritten log of all communications traffic including messages sent, received, relayed and related incidents or reports.
- Prepares comprehensive activity reports.

Education, Experience and Requirements

Minimum: Graduation from an accredited high school or general education development curriculum; or an equivalent combination of education and experience, substituting one (1) year of full-time paid employment as a radio operator in a city, county, state, commercial or industrial radio facility for each year of the required education up to and including a maximum of four (4) years.

Special Requirements: The ability to pass a thorough background secuity investigation to include fingerprinting. May include the ability to obtain A third Class radio-telephone license as issued by the Federal Communications Commission within sixty (60) days of employment and to successfully complete the Civilian Radio Operators School or its equivalent.

Knowledge, Ability, and Skill

- Must have a practical working knowledge of two-way radio communications procedure and equipment.
- Must have a working knowledge of state and local laws, motor vehicle regulations, drivers licensing, public safety and crime control procedures.
- Must have a practical knowledge of the highway and road system, the geographical area for which responsible including cities and towns and the type of terrain involved.
- Must have a working knowledge of basic office procedure, including filing systems and records keeping.
- Must be able to type accurately at the rate of twenty (20) words per minute as evidenced by a typing performance test.
- Ability to effectively and meaningfully express thoughts orally with an effective speaking voice, diction, and good telephone technique, and in writing by means of accurate spelling and legible handwriting.
- Ability to effectively think and act in emergency situations, when necessary to handle several messages simultaneously and function with speed, accuracy and emotional self-control.
- Ability to work irregular shift assignments under confining circumstances.
- Ability to deal tactfully, courteously and skillfully with the human relations and other problems which arise involving center personnel, agency law enforcement and public safety personnel and their commanders, and the general public in a knowledgeable and effective manner.

Results Expected

Provision of effective law enforcement and public safety communications and inter-service cooperation utilizing all Comm Center human and technical resources with accuracy, timeliness, efficiency and professionalism.

7.4 TRAINING AND DEVELOPMENT

There are few positions in the Law Enforcement - Public Safety service subject to more continuous scrutiny than that of the Communications Operator. It is a position in which a higher standard of performance must be the rule rather than the exception. Superior performance arises from devotion to duty and the determination to fulfill assigned responsibility.

The operator must accept the responsibility to fulfill the requirements of his position. This includes the prompt, accurate and courteous handling of communications in a highly professional manner. He will be only as effective as his own initiative and sense of responsibility indicate. Carelessness, lack of sincere effort, dishonesty or disregard for established regulation cannot be tolerated.

In order to fulfill the high standards of operational quality, effectiveness and professionalism established by the Governing Board, not only is it necessary that well-qualified people be recruited and selected for Comm Center operations, but also they must be trained and their proficiency maintained at a high level as well. In order to accomplish this, Comm Center operators should be assigned for the necessary period to the Civilian Radio Operators School conducted by the Iowa Law Enforcement Academy and approved by the Iowa Department of Public Safety for training or its equivalent.

In addition to the technical and professional instruction received in the classroom, each Communications Operator participant should receive instruction concerning human relations and relations with public and should be required to accompany a mobile unit for at least one full shift to observe the patrol officer in action. Comm Center operators should ride a minimum of one shift with the patrol officer at least once during his period of indoctrinary training and at least once annually thereafter. Greater mutual respect and understanding will surely result when each can become more aware of the problems faced by the other.

Training

The development of professional training courses for Communications Operators is a relatively new field. It is recognized as a necessary development in the upgrade of law enforcement communications personnel. Training experience has been developed for Illinois communicators based on a forty hour course provided at the Northern Illinois University, DeKalb, Illinois, and approved by the Illinois Local Government Law Enforcement Officers Training Board. This is reported in the APCO Bulletin of December 1973 (Vol 39, No.12).

Rapid development of the course content will occur in Iowa and elsewhere with the opening of the radio operators school. The following outline is intended to offer support for the activities of each course and add certain suggested topics, which will be helpful in operations of this system when implemented.

The course should be a minimum of 40 hours of intensive training. Instructors should be selected carefully based upon recognized professional skill and ability to express their experience. Instructors should meet qualifications similar to those of a Comm Center Supervisor outlined previously. The course should be directed by an individual who has an educational background, who knows law enforcement communications procedures and who is sensitive to the needs of law enforcement agency Communications Operators. The course effectiveness and students learning rate will benefit from the environment of a well managed training institute or vocational college. The time devoted to each subject will depend on content and upon the instruction staff experience, the needs of the class and the learning rate of participants. Since operational proficiency is desired, an equal priority should be placed on development of procedural skills and academic skills.

1. Orientation
   - Student processing, rules of conduct and facility familiarization
   - Course objectives, training goals, course content and instruction format
   - Study methods and course material introduction

2. Role and Qualifications of Communications Operator
- Communications interface between field and command officers
- Responsibility for routine policy implementation and information resources
- Maintains records of office status and activity
- Review general job description and qualification for position

3. Role of Supervisor and Law Enforcement Shift Command
- Discussion of supervisor's job description and qualification
- Teamwork and sharing the mutual knowledge with those being supervised and the officers of the agency staff.

4. Law Enforcement
- Basic statutes, processes (civil and criminal), and procedures
- Relations between agencies and with other public safety agencies
- Criminal Justice Standards:
  Police service responsibility
  Police officer role
  Patrol deployment
  Criminal investigation
  Command or control operations
  Radio communications
  Telephone system
  Communications and relations with the public.

5. Rules and Regulations
- FCC (Equivalent to 3rd Class Radio Telephone License). Encourage application
- Tactical Channel rules for usage.

6. Communications Procedures
- Message types and terminology
- 10 signal and phonetic alphabet; purpose, need and meanings
- Abbreviations
- Dispatching procedures
  Emergency Request - Techniques
  Telephone techniques
  Radio communications:
    Field officer actions (Operations)
    Information requests/response
    Tactical (Emergency)
    Point-to-Point (Intersystem)

Data Communications:

Computer terminology

TRACIS

NCIC

NLETS

Data formats

Emergency Procedures:

Disaster Mode - Civil Defense

7. Records, Logs and Retention
   - Recording (Tape) and playback
   - Filing and retention
   - Authorized disclosure policies
   - Logging of radio operations
   - Traffic records

8. Communications System
   - Base station subsystem

9. Communications Problems Laboratory
   - Role playing
   - Simulation practice (radio, telephone, data)
   - Composition of messages and use of codes
   - Action and reaction
   - Basic control and function of transmitters and receivers
   - Trouble detection and reporting
   - Maintenance reports and logs
   - Console functions
   - Controls
   - Switches
   - Adjustments

10. Examination

11. Post exam, critique

12. Graduation

8.0 STANDARD PROCUREMENT

This section is responsive to Task 14 of the Scope of Work for Phase II of the Iowa Telecommunications Plan.

8.1 INTRODUCTION

A unified approach to procurement is needed by each agency in order to implement the LEA communication system plan on a cost effective basis.

Procurement encompasses all factors which must be considered by an agency in order to effect physical implementation of communication system upgrade plans. As used in this report, the activity of purchasing is restricted to mean directed buying events necessary to achieve procurement goals.

The establishment of comprehensive procurement policies and detailed purchasing procedures can be an involved undertaking. It has been attempted in this section to discuss generally applicable procurement policies and purchasing procedures relative to technical services, Comm Center installation contracts, and communication equipment. The application of communication system procurement policies will vary between individual communication systems and precludes absolute uniformity. Procurement policies and purchasing procedures must be defined by those who are going to use and enforce such policies and procedures. The procurement of items such as desks, typewriters, paper, etc. is outside the scope of this report, and is not specifically discussed.

The overall context within which communication system procurement occurs is illustrated by the flow diagram of Figure 8-1. Several related events have transpired prior to the procurement function. Purchasing becomes active during the "Local Implementation" phase of system upgrade. Note that the local communication system administration must establish its funding capacity, procurement policies and purchasing procedures well ahead of time, during the "Local Planning" phase, to avoid program delays. Funding will result in constraints on procurement and purchasing; refer to Volume I, Section 2.3.

This section is organized to discuss general aspects of procurement and purchasing (Section 8.2); procurement policies for the local (city, county or regional) communication system administration (Section 8.3); and purchasing guidelines for the local communication system (Section 8.4). The contents of Section 8.3 and 8.4 may be used as a procurement manual by a local communication system administration.

8.2 GENERAL

Presently, each agency individually performs its own procurement function. No general bid law or procurement standards are in use. Only state agencies can request the Iowa General Services Department and the Division of Communications to assist in procurement activities. Reference 35 developed as the result of uncoordinated purchasing practices such as:

1. Many procurement specifications appeared to be prepared either by a vendor directly, or were written in such a fashion that only one vendor's hardware would satisfy the specifications, thus preventing other vendors from bidding responsively.
2. No bulk-buying practices were being exercised and small quantity purchases were common.
3. Insufficient guidance and incomplete understanding of proper procurement techniques caused wasted time in terms of repeated identical activities in separate agencies where many of these activities could be performed on a centralized basis.

Fortunately, implementation of the integrated communication system plan will adapt readily to more efficient purchasing procedures. For example, instead of individual agencies procuring for their communication needs only, the administration (Governing Board) of a communication system (city, county, or regional) may assume the procurement responsibility and satisfy the needs of all agencies within its political/administrative boundaries. These circumstances coupled with the detailed specifications and generic subsystem lists of equipment provided by this plan allow the development of unified procurement policies that will accomplish the following:

1. Encourage competition between vendors
2. Allow large quantity purchasing practices to be employed for certain subsystem equipments.
3. Increased quality as the result of equipment standardization.
4. Allow award of state-wide annual contracts for commonly used units and subsystems to reduce costs and the time required to complete procurement cycle.
5. Approach the most cost effective procurement (i.e. the lowest total cost including equipment costs, service, life, etc).

It is clear there are two (2) levels from which procurement requests may emanate:

(1) State - If the State of Iowa were to negotiate and issue annual contract(s) with a manufacturer(s) for commonly used communication equipment for distribution around the state; very cost effective contract(s) may be written. Relative to such centralized purchasing, the State of Iowa is not now able to warehouse, store, ship, and invoice for communication equipment purchased under one unifying purchase contract with a manufacturer. It may be possible, however, that the state General Services Department can, at the request of a state agency (i.e. Crime Commission) establish a single purchase order with a vendor which defines prices, delivery point and billing point for specific local communication systems. To be effective, such a contract must guarantee some minimum level of procurement and become subject to open bidding on an annual basis.

Under this system, the administrative entities defined in the purchase order would gain a price advantage, however, each would be responsible to individually negotiate delivery, installation, payment and warranty performance with the vendor.

(2) Communication System Administration (Local) - Where all communication system purchasing for agency sub-elements for the local (city, county, or region) communication system flows through the local communication system purchasing agent.

The benefits which may be achieved by the state-wide plan will be realized as the plan is implemented, with full benefits being enjoyed only when full implementation is achieved. Prompt implementation will be cost effective from two points-of-view:

(1) Inflationary trends increase equipment and labor costs with time.
(2) Delays in implementation cause the use of tax dollars to support the present inefficient communication systems.

Local communication system administrations have personnel capable of carrying out implementation in accordance with the plan. These administrators, however, have many other activities to perform and may not necessarily have the time to devote the concentrated attention needed to cause prompt implementation. As a result,,it appears advisable for local administrators to request assistance from available resources.

The Area Crime Commission Director can assist in the following functions:

(1) Identification of areas (cities, counties or regions) where assistance is needed to clarify the agency content and jurisdictional area covered by the integrated communication system.
(2) Local planning, specifications and fund request preparation, following same through the fund approval cycle.
(3) Technical procurement activities of a local communication system relative to bid request preparation, bidders' conference participation, bid response evaluation, and preparation of the final purchase order.
(4) To supply or contract for system implementation architectural services relative to monitoring contractor progress in construction of base, repeater, and Comm Center sites.
(5) To perform or contract for an independent evaluation of a contractor's installation and/or equipment to assure that performance requirements have been satisfied.

The State Communications Advisory Committee for law enforcement agencies can assist to provide continuing plan development, general guidance and "sounding board" liaison relative to state-wide LEA communications.

The preceding activities represent a significant number of man-hours and would, if adopted, require some portion of the funds to be used for additional personnel in the Crime Commission and/or the Division of Communications and/or the establishment of contracts with competent communications system consultants.

8.3 PROCUREMENT POLICIES

8.3.1 SCOPE

Each local communication system administration (Governing Board) should develop or adopt generally applicable procurement policies which include guidelines to be used by the purchasing agent. These policies shall be written in terms of the nature of equipment and services being purchased. Also, these policies should provide special guidance in accordance with detailed requirements established by funding sources (Reference 24 and 25).

Figure 8-2 presents the primary flow of activities associated with local procurement and purchasing. Each activity shown is performed during procurement regardless of whether a single item or a complex system is being purchased. A discussion of the numbered events shown in Figure 8-2 follows:

1. Decision to Implement - - A series of events during which administrative decisions are made, the local governing organizations are established, and the boundaries of the local communication system (city, county, or regional) are determined. With these items accomplished, the procurement activities may be started.

2. Define Specific Requirements - - In accordance with the requirements delineated in the Iowa Telecommunications Plan and modified to reflect the specific characteristics of the local communications system. It is necessary to select appropriate equipment specifications, Comm Center specifications, determine organizational specifications, delineate personnel requirements, and provide budget projections depending upon the scope of items to be procured.

3. Develop Funding Sources - - It is necessary to know how much money is available, what restrictions are placed on the use of the money, how

payment is made and when the money will be available. See Volume I, Section 2.3 for steps to secure grants for the use of LEAA and DOT funds.

4. Assign Purchasing Responsibility - - The procurement function is most effective if all purchasing is centralized through one agency (or person) who is designated to have purchasing responsibility. All vendor inquiries and contacts, as well as purchasing commitments should be arranged through this agent. Such an approach leads to efficient ordering of equipment, services, and installation, thus eliminating duplication of effort and simplifies both purchasing procedures and the payment of invoices.

   A competent purchasing agent with qualified technical assistance should be able to deal with vendors on technical details, use, and cost of the items he is required to buy. Such an individual should have an analytical mind and a willingness to work cooperatively with all members of the communication system administration. A description of the requisite skills is available from the General Services Department, Division of Communications.

5. Prepare and Issue Invitations for Bids - - The Invitation for Bid (IFB) should be sufficiently detailed and specific that each vendor will reply on the same basis relative to technical performance, design features and delivery. If options are desired, these should be defined in the IFB. Options to be bid may include; (a) various levels of complexity of requirements, (b) standard available options, (c) quantity, and (d) cost of exceptions recommended by the vendor and which may be granted to all bidders.

   The IFB should specify system functional and performance requirements, leaving some latitude to the prospective vendors to; (a) make comments, (b) take minor exceptions to the standard specifications, (c) propose the use of equipment and techniques they believe to be most effective, and (d) guarantee that any exceptions will meet all functional and performance requirements.

A bidders' conference is needed whenever the equipment or services being acquired represent significant dollar value and/or is technically complex. This conference will lead to clarification of the bid package contents, and help reduce misunderstandings. For complex purchases, attendance at the bidders' conference may be considered a mandatory requirement.

After a period (such as one week) following a bidders' conference, on a day clearly defined to all concerned, the purchasing agent must no longer receive comments and will proceed with construction and mailing of the final IFB package.

The final IFB should contain, in addition to technical specifications, quantities and delivery, a set of terms and conditions. Terms and conditions information should be obtained from the funding agency at the time of purchasing as these items tend to change with time. In the event that a local purchase is made where no terms and conditions guidance is available, the purchasing agent must develop a set covering in general the items provided in Section 8.4.

It is valuable for the IFB to require that the vendors submit an intention-to-bid letter approximately halfway between the time the quotation request is issued and the full bid response is due (after the bidders' briefing).

If desired, a formal "bid opening" may be performed on the day and time when all bids are due. At an opening, all responding vendors are identified and the total dollar amount of each bid is read. No details which may be of a proprietary nature to a vendor (i.e. how the requirements are met) are discussed or revealed.

6. Evaluate and Select Vendor(s) -- It is important that the purchasing agent plus other advisory or consultants competent to evaluate the bids received, make vendor selection relative to technical compliance with the items listed, provide assurance of performance and warranty, and compare all costs on an equal basis between vendors.

The bid-evaluation team should consist of the purchasing agent, one or more responsible members of the communication system administration, the Area Crime Commission Director, and depending upon policy; local and funding agency technical consultation provided by communication system consultants who may be representatives of the Division of Communications.

An important aspect to be recognized is that of defining the field service and warranty requirements. It is necessary to eliminate any supplier who cannot demonstrate the ability to service or warranty the equipment.

When all remaining bids are comparable on a equal basis relative to the quality of items and competence of services to be delivered, the lowest dollar bid should be selected. After final selection, all respondents should be promptly notified of results.

7. Issue Purchase Orders - - Following the selection of the vendor, the contents of the actual purchase contract are negotiable. That is, the successful vendor has described the detailed equipment lists and methods to be used in his bid response. These items must be written as a statement of work into the purchase order and any fiscal negotiation relative to standard terms and conditions, if any, must be identified and written to the mutual satisfaction of the contracting parties. Also, at this time, the final selection of options is made. Such negotiations are usually conducted in a meeting rather than by letter. Caution is advisable to avoid developing a purchase agreement which were not available to competing vendors, or which increase the number of equipments ordered when suchan increase should require a rebid opportunity to vendors. Once negotiations are complete and the final purchase contract is found satisfactory to the funding agency and local communication system administration, the purchase order is issued.

8. Delivery and Installation - - The purchasing agency must schedule the receipt of the ordered items and establish construction schedules to achieve the schedule of implementation. Follow-up and monitoring of vendor progress is necessary to determine whether or not delays will be encountered in shipment. Such monitoring of contractors may be accomplished through progress reports and/or a system consultant, an architect or engineer hired for such a purpose. Monitoring is an active process and must be pursued vigorously by the purchasing agency and his consultants.

9. Verify Compliance - - The received goods and services must be compared with the ordered goods and services to assure that the suppliers have complied with the purchase order and its specifications. Installation of complex equipment requires proof of performance and operational testing by the vendor or installer to assure that specifications are met.

10. Authorize Payments - - After developing assurance that the suppliers have complied with the purchase orders and contracts, it is necessary to provide approval guidelines so that the purchasing agent may authorize compensation for vendor efforts in compliance with the terms of the purchase order.

8.3.2 POLICY FACTORS

The establishment of procurement policies must be accomplished by the administration of the local communication system. The local communication system administration may be supported by state-wide agencies, (such as the LEATAC), however, resultant policies should allow utilization of the normal purchasing mechanisms of the agencies which constitute the local communication system. There are four (4) factors which must be controlled by procurement policies.

(1) Quality,
(2) Quantity,
(3) Time,
(4) Price.

A fundamental assumption relative to procurement is that the administration responsible for the local communication system (city, county or region) will handle all purchasing for the communication items utilized within its own system. Requests for equipment and services issued from individual agencies within the communications system are expected to result in purchase of the items by the communication system purchasing agent. This can include participation in state-wide central purchasing contracts established by the Iowa

Department of General Services for commonly used communication equipment. The methodology employed by the communication system administration in processing requests for equipment and/or services from agencies within itself is considered to be the responsibility of the system administration. (For example; a dispatcher may place a request for an equipment through the Comm Center Director. If the Director agrees, he then forwards this request with his approval to the purchasing agent. The purchasing agent or Director will identify the source of funds, and the purchasing agent will collect specifications, gain approval of the request and issue an invitation for bid).

Quality refers to the control of kinds of goods or services desired as established by the specifications used to purchase such items. The contending vendors must be evaluated relative to their ability to meet specifications, provide warranty, provide maintenance, and meet schedules.

The key to maintaining quality for a technically complex and interrelated group of technical items is a direct function of the quality of the specifications. Detailed equipment specifications appear as the Specification Appendix to Volume I of this report. Utilizing these specifications will establish a baseline of functional technical requirements suitable for achieving quality communication system implementation. The probability is high that a law enforcement administration will need technical guidance in the preparation of communication system purchasing plan and specifically in the interrelationship of these specifications with the present capability of a particular agency. Further, compliance with the overall Iowa Telecommunication Plan specifications is necessary to assure that the final installation will be in accordance with that plan. One method of achieving the needed assistance is to request a review of the IFB statement of work by competent advisors prior to purchasing. In grant applications for LEAA funds, it is the responsibility of the Crime Commission to assure compliance with the plan.

The quantity of the item purchased will generally be determined directly or indirectly as a result of an assessment (reference Section 2.2.8 of Volume I; Table 2-17, "worksheet") of the equipment items currently available and those which are needed to implement the local communication system.

The <u>time</u> allowed for delivery of each item and/or service is linked to the schedules established for system implementation and often is affected by funding schedules. Except for small item procurement, it is very important that a procurement schedule be derived to guide the purchasing agent such that the flow of materials and services will lead harmoniously to the desired implementation activities. Note that it is necessary to allow realistic vendor delivery schedules to avoid cost penalties.

<u>Price</u> is the responsibility of the purchasing agent, for it is his contacts with outside vendors that allow him to determine what is a fair price. The best results can be secured where prices - and for that matter, all of the procurement factors - are discussed among and approved by the local communication system agencies. Price is strongly affected by the ability of the purchasing agent to collect competitive bids.

Table 8-1 is descriptive of fundamental factors which influence price. In the event that certain communications system equipment and/or services are available on a state-wide basis, rather than through local purchasing only, the prices of these items could be expected to be favorable and essentially non-negotiable for the local system purchasing agent.

8.3.3 POLICY DETAILS

It is important to establish consistent purchasing policies. If the purchasing agent is known for fair dealings with vendors he is likely to gain the respect and confidence of the vendors, which in turn will be reflected in improved service and response. To that end, communication system administrative purchasing policies should cover the following items:

(1) The purchasing agent should maintain a judicial attitude such that the relationship between his organization and vendor causing both to be dealt with fairly.

(2) Everyday social and business courtesies should apply in relationship with vendors and their representatives.

(3) Advertising for bid - qualified vendor list(s), papers, journals, and news media which are to be used when a bid invitation is issued.

(4) Define clearly who is to negotiate contracts with a vendor and represent a system and its agencies during the IFB period.

(5) Identify items where outside help is required (such as architect or engineer) and how these services are to be obtained.

(6) Guidelines are needed relative to point of delivery and methods of billing payment. (For example: define whether progress payments are allowable).

(7) If bonding requirements are to be applied, especially for installation or construction contracts, the guidelines by which bond value and posting requirements should be established.

(8) Policy guidelines are necessary to cover items like equal opportunity, OSHA, liability insurance, workmans' compensation, and other federal and state acts relative to procurement and the use of funds.

(9) The acceptance of personal gifts or favors from vendors should be discouraged as they may influence the purchasing agent's decisions, or lead to suspicion of involvement in unfair practices.

(10) Avoid constant pressure or "rush" orders since these priorities, if used indiscriminately, will lead to broken delivery promises and extra costs.

(11) In the event of purchasing order cancellation due to no fault of the supplier, be prepared to provide termination payments to the supplier for committments he has made as a result of receiving the purchase order.

(12) Policies must determine precisely who is responsible to represent the administrative system which is placing the purchase orders ,after the orders are placed.

(13) Policies must define clearly who authorizes purchase and the cost dollar levels at which increased authorization is required.

(14) Policies to resolve conflicts of interest. Such items as prohibiting the vendor who prepared specifications from also providing equipment are important.

(15) Policies to determine how funding requirements may be met.

(16) Policies should eliminate restraint of trade.

(17) Policies should clearly define how to control invitations for bids.

(18) Policies should determine the type of contract versus the level of financial activity and funding source for that contract. (A contract may be for a certain quantity of an item or service at a fixed price; for certain goods and services at a given rate and a given profit up to, but not exceeding a limit amount; but contracts should never be for a price plus fixed fee with no limit amount).

(19) Policies should recognize the purchase of low-value or miscellaneous items where the purchase order is for $50.00 or less. Within clearly defined guidelines, it may be advisable to allow the purchasing agent a free hand in issuing small value purchase orders to reduce administration costs.

(20) Policies should recognize the purchase of single items which have medium to high value. These are non-discretionary purchases for the purchasing agent of equipment (not services) items. Define how approval is achieved for these purchase orders.

(21) Policies should cover the purchase of multiple items of medium to high value. The dollar value of this purchase order is probably quite high and compliance with funding agency requirements must be met.

(22) Policies should cover service contracts for activities such as equipment installation, equipment check-out, services, and consulting fees requiring policy guidance beyond that which is established for the purchase of hardware items. In some instances it is advisable to use consultants to assist in the definition of what is to be purchased, and how to purchase it, and to assure that performance verification tests are accurate.

(23) Purchase orders issued for construction to include remodeling, Comm Center installation, and the building of new physical facilities requires unique consideration. Contracts for services in the construction area are, as a general rule, more complex than other contracts issued by the purchasing agent. It is advisable to have professional assistance in preparing the terms of the construction contracts.

FIGURE 8-1 SIMPLIFIED PROGRAM FLOW FOR LOCAL COMMUNICATION SYSTEM UPGRADE

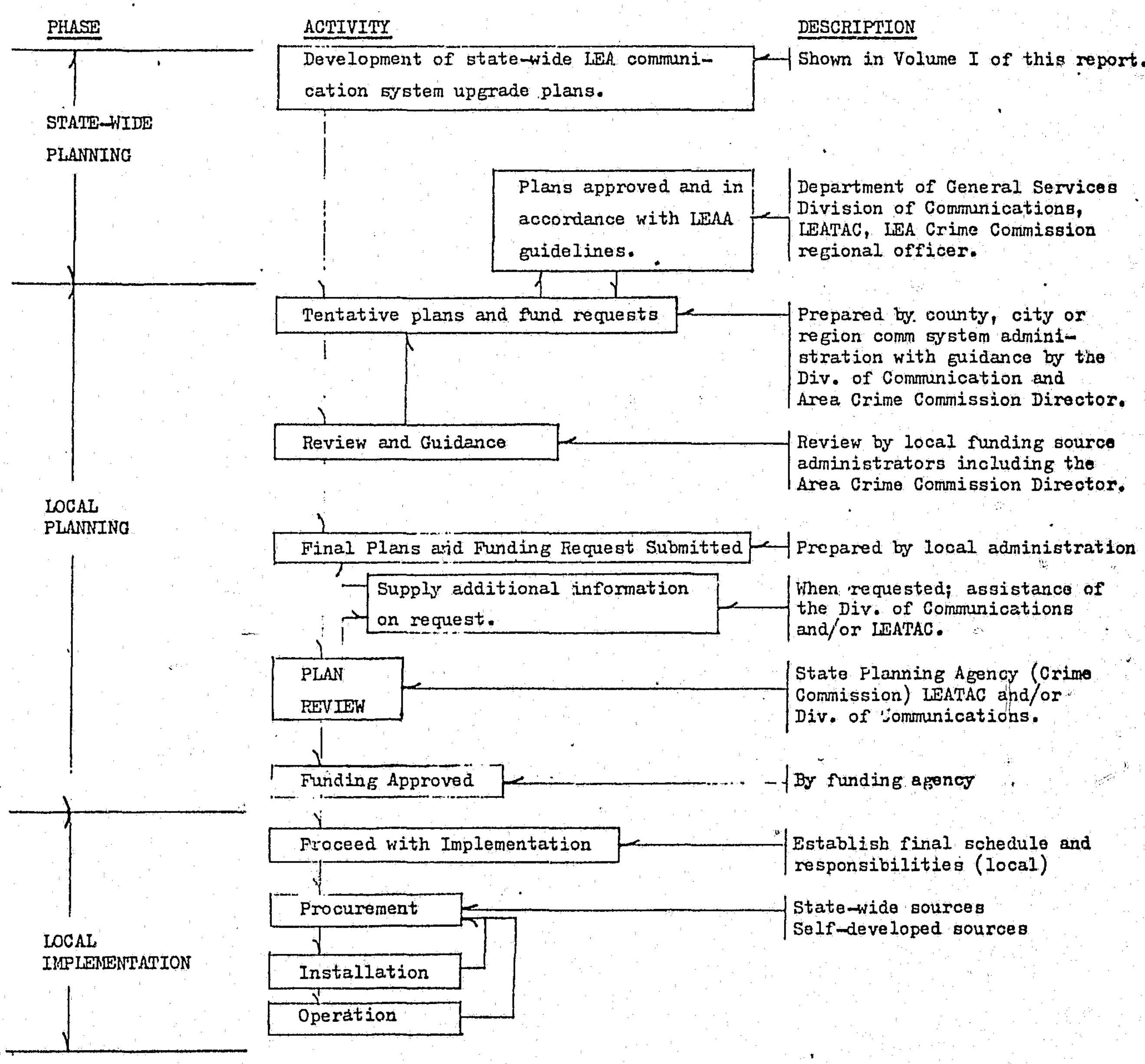


FIGURE 8-2 GENERALIZED PROCUREMENT ACTIVITIES*

No.	EVENT FLOW
1.	DECISION TO IMPLEMENT
2.	DEFINE SPECIFIC REQUIREMENTS
3.	DEVELOP FUNDING SOURCE
4.	ASSIGN PURCHASING RESPONSIBILITY
5.	PREAPARE AND ISSUE INVITATION FOR BID (IFB): ISSUE PRELIMINARY BID PACKAGE — BIDDERS CONFERENCE — RECEIVE LAST COMMENTS — PREPARE FINAL IFB — ISSUE FORMAL IFB — INTENTION TO BID LETTERS — BID OPENING
6.	EVALUATE, SELECT, AND NOTIFY VENDOR
7.	WRITE PURCHASE ORDER: FINAL NEGOTIATION — ADMINS & FUNDING APPROVAL — ISSUE P.O. → EQUIPMENT, INSTALLATION, SUPPLIES, SUPPORT
8.	DELIVERY AND INSTALLATION
9.	VERIFY COMPLIANCE
10.	AUTHORIZE PAYMENT

* See text for explanation of each event.

TABLE 8-1 PRICE FACTORS

Chart of items affecting cost when acquiring a group of like equipment, for example; several mobile radios or several personal portables.

P. O. ITEM	INFLUENCE	PRICE EFFECT INCREASE	PRICE EFFECT DECREASE
1. Rapid Delivery .	1. Causes special handling, less efficient methods, overtime and other premium charges.	X	
2. Small Quantity	2. Often requires as much adminstrative support as large quantity orders.	X	
3. Large quantities with paced delivery.	3. Allows supplier assurance of continous activity at a predicted rate.		X
4. Group or central purchasing.	4. Increases order size and reduces sales and administrative costs.		X
5. Single Point Delivery	5. Simplifies vendor shipping		X
6. Package purchasing from one vendor, i.e. statewide purchasing of communication equipment.	6. A "Package" may include all portables, mobiles, and base stations under one contract. Reduced administration for buyer and vendor. Reduced marketing costs. Possible improved function. Total price is important rather than individual prices of items.		X
7. Twelve (12) month contract associated with package purchasing.	7. Increases quantities, uniform delivery, assures Annual chance for competition.		X
8. Tight technical specifications.	8. Specifing performance in excess of that required to meet system performance requirements and life.	X	
9. Unclear Specification	9. Allows misunderstanding and may force acceptance of unsatisfactory equipment.	X	
10. Group P.O. with no quantity guarantees.	10. Causes much paper work for vendor and no assurance of volume nor minimum quantities.	X	
11. Warranty Terms	11. Clear defininition of warranty as warranty affects operational costs.		X
12. Maintenance Available	12. Vendor with competent responsive maintenance ability; [illegible]tive to operational costs and time losses.		X

(24) Warranty and maintenance are important elements of both equipment and services contracts. Reference Section 5.0 for guidance relative to maintenance. Warranty involves the methodology used to remedy defects in received goods and services during the warranty period.

8.4 PURCHASING GUIDELINES

This subsection presents a list of duties for the communication system purchasing agent (8.4.1); and three sets of guidance material and standard paragraphs which may be used as guidelines to writing an Invitation for Bid (8.4.2) , general Terms and Conditions relative to the purchase order (8.4.3), and Scope of Work (8.4.4).

The IFB (8.4.2) standard paragraphs are a series of considerations essential to developing the final purchase order. Some items covered in 8.4.2 are redundant with information in some paragraphs of 8.4.3 and 8.4.4, however, the redundancy is needed to assure completeness and will be eliminated in the final contract.

The final purchase contract will consist of three essential sections; (1) Introduction, (2) Terms and Conditions, and (3) Scope of Work.

A suggested Table of Contents for a purchasing contract follows:

SECTION	TITLE AND DESCRIPTION
1.0	Introduction
1.1	Description - A brief overview description stating the general objectives to be achieved, for who, by whom, where and when.
1.2	Acceptability - State that the SOW and its attached specifications define the minimum acceptable physical and performance requirements of the equipment and/or system to be supplied.

SECTION	TITLE AND DESCRIPTION
1.3	Definitions - State definitions of "Owner" "Contracting agency", "Engineer", "Contractor" and "Subcontractors" if not elsewhere listed. Provide other definitions if needed for clarity (i.e. the word "site" may be defined to mean a specific portion of a specific building, etc.).
1.4	Requirements: Present the administrative data needed to specialize the standard paragraphs for Terms and Conditions and SOW to the contract under consideration. Use Section 8.4.2 as a check list to develop this section.
2.0	General Requirements:
2.1 etc.	(all applicable Terms and Conditions as per Section 8.4.3)
3.0	Statement of Work (SOW)
3.1 etc.	(all applicable SOW items as per 8.4.4)
4.0	Appendix
4.1 etc.	(display of detail specifications and other related documents).

8.4.1 PURCHASING AGENT DUTIES

The following minimum purchasing procedures should be established as duties for the purchasing agent by the local communication system administration. It is expected that the purchasing agent would apply the procedures to his specific purchasing requirements and that he will be able to match the sope of his activity to the size of the purchase order to be issued.

(1) The purchasing agent shall develop a purchasing procedure file consisting of the local communication system purchasing guidelines to be used, as applicable, in terms of the nature of equipment or services being purchased.

(2) The purchasing agent must know and maintain records showing possible materials and substitutes, sources of supply, prices, and quantities available.

(3) The purchasing agent must review specifications for possible simplification and standardization of materials or to eliminate unreasonable requirements.

(4) The purchasing agent shall enter into negotiations with vendors as a representative of the communications system administration.

(5) The purchasing agent shall accumulate and evaluate quotations, making recommendations relative to the selection of suppliers.

(6) The purchasing agent shall write and place purchase orders with the suppliers.

(7) The purchasing agent shall be responsible to follow vendor progress require vendor progress reports after the purchase orders have been issued, and to determine whether delivery will be achieved as specifie

(8) The purchasing agent shall review invoices to verify compliance with the terms of the purchase order and approve compensation for vendors.

(9) The purchasing agent shall be responsible for maintaining records of all purchases.

(10) The purchasing agent shall coordinate with all affected agencies and individuals on all matters pertaining to procurement.

8.4.2 STANDARD PARAGRAPHS: INVITATION FOR BID

There are a number of items which must be recognized when establishing an Invitation For Bid. These items and an approach to covering same are presented in the following material. Caution is required in the application of standardized material to specific applications; judgement must be exercised as the nature and complexity of the product or service being purchased will affect the extent to which standard paragraphs apply. That is, for very simple purchases it would be neither necessary or economical to formally apply all paragraphs.

Excellent guidance is obtained by reviewing the State of Iowa, Department of General Services Purchasing Division, "Agency Procedures and General Information Manual". A communication system purchasing agent should obtain a copy of the procedures and use them as a guide to purchasing. Also, review LEAA Guidelines to Grantee Procurement Standards and Procedures when LEAA funding is involved.

In addition to a preliminary draft of Standard Terms and Conditions and the Scope of Work, an Invitation For Bid should cover the following:

1. Name of the purchasing agent, his telephone number and mail address.
2. Date, hour and location where bids will be received. Late bids will not be considered.
3. Requisition number and request that the vendor reference same when making inquiries, such inquiries may be made by telephone and followed in writing, to be received no later than 10 days prior to bid closing.
4. A complete description of the item (or services) being purchased, units of measure for each item, and quantities of each item.
5. A clear definition of delivery dates and location (address) for each item.
6. Ask for prices per unit of measure and extended total cost of all items.
7. Define where billing will be made for each item if different than that given in (1).
8. Define, and ask the vendor to verify, the shipping point, i.e. items to be supplied F.O.B. (your address).
9. Terms of payment i.e.; 2% 10 days, net 30 days or similar trade discounts, if applicable, which are allowed.
10. Require the bidders to sign a statement agreeing to meet the scope of work (items to be shipped) on the given schedule if awarded the purchase order. This statement must accompany the bidder's response.

11. Require the bidder to either submit a letter of intent to bid within a period approximately midway between the time the IFB is issued and the date bidding is closed or attend a bidders briefing. Failure to do this should be cause for rejection of bidder.

12. Provide a complete set of terms and conditions applicable to the procurement.

13. If unknown, require the bidder to provide sufficient information for the reviewer to determine the ability of the bidder to respond if selected. This should include: corporate (or business) description, names of key managers, examples of like projects (equipment) previous or currently performed, name of bidder's representative responsible to assure compliance and financial statement.

14. Require bidders to identify major subcontractors, if any, and qualifications thereof.

15. When a bid guarantee is required, state that the bid must be accompanied by a certified check or chashier's check or draft for 5% (or other) percent) of the bid amount payable to (specify), or a bid bond (specify amount) issued by a surety authorized to do business in Iowa, payable to the communications system purchasing agency (1) or other specified representative in event of award. The amount should cover all additional alternates to the bid.

16. As applicable, state that the bid must include all costs for all labor and materials, water, fuel, heat, tools, plans, equipment, lights, power, transportation, etc. necessary for the proper completion of the work.

17. As applicable, state that bidder is reponsible to verify all physical and electrical measurements of the site prior to ordering materials, and is responsible for same. Differences between any described information and actual information must be brought to the attention of the (purchasing agent, engineer, etc.). Further, the bidder shall be held to have examined the site and understands the conditions thereof prior to bidding.

18. State how soon work must start like ten (10) calendar days after issuance of the written order to proceed).

19. Advise bidder that any person or firm to whom a subcontract would be issued must; (a) be acceptable to the purchasing agent, and (b) must make the same certifications to the prime contractor that the prime contractor has made the purchasing agency.

20. Ask for a statement of compliance, i.e. that the bidder responds completely to the items to be bid. If not, the bidder must; (a) identify the differences, (b) state the reasons for deviation, and (c) describe his alternative approach.

21. State that it is the right of the purchasing agency to reject and and all bids and to waive all informalities.

22. Ask bidder to state whether he has participated in a previous contract or subcontract subject to the Equal Opportunity clause, and if not, how he intends to comply.

8.4.3 STANDARD PARAGRAPHS: TERMS AND CONDITIONS

Depending upon the formality and scope of the items, services or installation being purchased; the terms and conditions associated with the purchase order will cover the following paragraphs to varying degrees. Again, caution is advisable as judgement is required in the extent of applicability of each item. For complex purchases, such as installation of a communication center, the terms and conditions must be extended into greater detail by an architect or engineer. Definition of the work to be done is accomplished by providing a Scope of Work (8.4.4) with these standard Terms and Conditions.

Terms and Conditions should cover the following: (NOTE: Those paragraphs maked with an asterisk (*) require action or specialization prior to use, or are instructions. Other paragraphs may be used directly.)

1. DEFINITIONS: *

(a) Owner: When the Owner is referred to in these specifications it shall mean name of local communications system or agency.

(b) Contracting Agent: The authorized Contracting Agent for the Owner is name of authorized representative.

(c) Engineer: The engineer referred to in the specifications is name of consultant or authorized representative.

(d) Contractor: The contractor shall be the individual or organization contracting to do the work and furnish the materials, equipment and transportation provided for the in-contract Statement of Work.

(e) Subcontractor: Any individual, organization to whom the Contractor sublets any part of the contract for supplying materials and labor, or only labor, at the site of the project.

2. CONTRACTS *

All contracts shall be made and set forth in writing and shall be signed on behalf of the local communication system by the proper officials thereof and with the formalities required by the governing statutes regulating the particular public corporation involved. If sums are to be withheld to assure full compliance, for issue after testing or other verification of per ormance, so state.

3.1 PAYMENTS *

(a) If progress payments are allowed, state the formalities to be used, recognizing withheld sums (per Item (2) above) if any.

(b) Final payment of all sums due to the Contractor shall be made within thirty days (30) after the completion and acceptance of the public improvement by the public corporation.

3.2 PERFORMANCE AND PAYMENT BONDS

(a) The Contractor shall, before a contract is signed or purchase order issued, furnish surety satisfactory to the Owner in an amount not less than the contract price, for the faithful performance of the contractor with the additional obligation that such contractor shall promptly pay all persons supplying him labor or material in the prosecution of work provided for in the contract. Such performance and payment bond shall be furnished to the Owner or his authorized agent within ten days after the date of the award. Failure on the part of the bidder to furnish such bond in the time stated shall be cause for consideration by the Owner of awarding the Contract to the second low bidder and the retention of the bid deposit.

(b) In case of a partnership contract, each partner must sign the bond.

4. BIDS

(a) Each bid must be accompanied by a certified check, cashier's check, or draft, for five percent (5%) of the amount of the bid including all add alternates, such check to be certified or issued by either a solvent State or National Bank payable to the Public Corporation as a guaranty that such bidder will enter into a contract with the Owner in accordance with the terms of the letting and bid in case such bidder be awarded the contract. Bid bonds are acceptable as bid security under these specifications, see next paragraph.

(b) Bid Bonds: In lieu of a certified check as a bid guarantee, a bid bond of five percent (5%) of the total amount of the bid, including all add alternates, may be furnished by the Contractor. Such bond to be issued by a surety authorized to do business in Iowa. Such bond shall be payable to said public corporation or officer as guaranty that such bidder will enter into a contract with said public corporation, its board or officers thereof, in accordance with the terms of such letting and bid in case such bidder be awarded the contract.

(c) No bidder shall be required, either in the Advertisement for Bids or otherwise, to leave his certified check or other guaranty posted for longer periods then ten (10) days if his bid is not accepted. The certified check or other guaranty of the successful bidder shall be returned to him forthwith upon the execution of the Contract and surety herein provided for.

(d) The certified checks or bid bonds of all the unsuccessful bidders shall be immediately returned and not more than thirty (30) days shall elapse between the time of the opening of the bids and either the acceptance of the bid of the lowest responsible bidder or the rejection of all the bids presented.

(e) Any bid may be withdrawn by letter or by telegraphic communication or in person before the time specified in the advertisement therefor. Bids may be modified by mail or by telegraphic notice received at the place designated in the invitation to bid not later than the time set for the opening of bids. Telegraphic modification shall not reveal the bid price, but shall provide the addition or subtraction of the modification so that the final prices or terms will not be known to the public corporation until the sealed bid is opened. Any telegraphic modification may not be withdrawn after the time set for the opening of bids. Telegraphic modifications must be confirmed in writing by the successful bidder before award of the contract. No bid made shall be changed or altered by telephone. No oral changes, alternations or conditions will be accepted under any circumstances.

5. INSURANCE

The contractor shall not commence work under this contract until he has obtained all the insurance required under this paragraph and such insurance has been approved by the Owner, nor shall this contractor allow any subcontractor to commence work on his subcontract until the insurance required of the subcontractor has been so obtained and approved. Each contractor and subcontractor shall maintain for the life of the contract such Workmen's Compensation, Public Liability and Propert Damage Insurance and Automobile and Truck Insurance as will protect him from all claims which may arise from operations under this contract whether such operations be by himself or by any subcontractor or any one directly or indirectly employed by either of them and also against any special hazards which may be encountered in the performance of this contract according to the following requirements:

(a) Workmen's Compensation Insurance - The contractor shall maintain such insurance for the life of the contract as will protect himself and the Owner from claims under Workmen's Compensation Acts.

(b) Public Liability and Property Damage Insurance - The contractor shall maintain for the life of the contract, Public Liability and Property Damage Insurance with minimum limits of $100,000 for bodily injuries, including accidental death, to any one person and $300,000 for more than one person in any one accident. The minimum limits for Property Damage Insurance shall be $100,000.

Additionally, coverages should be required covering injury to, and destruction of, any property due to the collapse or injury to any building due to factors such as: grading or excavation, moving or modification of a structure, injury to wires, pipe, conducts, etc., injury to any public or private property including paint, explosion or blasting and subcontractor actions.

(c) Automobile and Truck Insurance - The contractor shall keep and maintain for the life of the cont Automobile and Truck public liability, bodily injury and property damage insurance with minimum limits as follows:

(1) Injury to, or death of, one person - $100,000.

(2) Injury to, or death of, more than one person in a single accident - $300,000.

(3) Property Damage - $100,000.

(d) Builder's Risk Insurance:- The contractor, to the satisfaction of the owner, must maintain adequ builder's risk insurance.

(e) Certificates of Insurance -

(1) Certificates of the above insurance shall be filed with the Contracting Agent and shall be subject to the Owner's approval for adequacy of projection. Each respective Contractor and subcontractor shall provide the certificates for the insurance herein before required. The insurer shall state in his certificate that no cancellation of said insurance will be made without at least thirty (30) days prior notice to the Owner and such notice shall be direct to the Contracting Agent in writing.

(2) The Owner's or Contracting Agent's approval or acceptance of such certificates of insurance in no way release or relieve the respective Contractor from any responsibility, liability, o obligation devolving upon him.

(3) All insurance policies and certificates shall be issued only by companies authorized to do business in the state of Iowa. It shall be the Contractor's responsibility to keep the resp tive insurance policies and coverages current and in force for the life of the Contract.

6. PLANS AND SPECIFICATIONS

Plans and Specifications shall be furnished by the Contracting Agent upon the request of the Owner, either directly or through the Engineer.

7. SHOP DRAWINGS

(a) The Contractor shall submit to the Engineer with such promptness as to cause no delay in his own work or in that of any other Contractor, five (5) copies of all shop or setting drawings and sched required for the work of the various trades.

(b) The Engineer, under the supervision of the Contracting Agent shall pass upon them with reasonable promptness and return two (2) copies to the Contractor. The Contractor shall then make any corrections required in the passing upon of the drawings and furnish such other copies of correcte shop drawings as may be required. In the event of a dispute as to the adequacy, completeness, and conformance of materials and construction with the Plans and Specifications, the written ruling of the Contracting Agent shall be final.

(c) The approval of the shop drawings by the Engineer or Contracting Agent or his authorized representa tive shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. Approval of such drawings will not relieve the Contrac of the responsibility for any error which may exist as the Contractor shall be responsible for the dimensions and design of adequate connections, details, and satisfactory construction of all work.

8. PLACING DRAWINGS AND SPECIFICATIONS

The contractor shall keep a copy of all drawings and specifications on the work, in good order, available to the Engineer or Contracting Agent and to their representatives.

9. PATENTS

(a) The Contractor shall hold and save the Owner and its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses, for, or on account of, any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the contract, including its use by the Owner, unless otherwise specifically stipulated in the Contract Documents.

(b) License or Royalty Fees: License and/or Royalty Fees for the use of a process which is authorized by the Owner of the project must be reasonable, and paid to the holder of the patent, or his authorized licensee, direct by the Owner and not by or through the Contractor.

(c) If the Contractor uses any design, device or materials covered by letters patent or copyright, he shall provide for such use by suitable agreement with the Owner of such patented or copyrighted design, device or material. It is mutually agreed and understood that, without exception, the contract prices shall include all royalties or costs arising from the use of such design, device or materials in any way involved in the work. The Contractor and/or his sureties shall indemnify and save harmless the Owner of the project from any and all claims for infringement by reason of the use of such patented or copyrighted design, device or materials or any trademark or copyright in connection with work agreed to be performed under this Contract, and shall indemnify the Owner for any cost, expense or damage which it may be obligated to pay by reason of such infringement at any time during the prosecution of the work or after completion of the work.

10. SURVEYS, PERMITS AND REGULATIONS

(a) The Owner shall furnish all preliminary surveys unless otherwise specified. Permits and licenses of a temporary nature necessary for the prosecution of the work shall be secured and paid for by the Contractor. Permits, license and easements for permanent structures or permanent changes in existing facilities shall be secured and paid by the Owner, unless otherwise specified.

(b) The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work as drawn and specified.

11. PROTECTION OF WORK AND PROPERTY

(a) The Contractor shall continuously maintain adequate protection of all his work from damage and shall protect the Owner's property from injury or loss arising in connection with this Contract. He shall adequately protect adjacent property as provided by law and the Contract documents.

(b) He shall provide and maintain all passage ways, guard fences, lights and other facilities for protection required by public authority and local conditions.

12. INSPECTION OF WORK

The Owner and his representative shall at all times have access to the work wherever it is in preparation or progress and the contractor shall provide proper facilities for such access for inspection. The contractor shall give the Owner, or the Engineer representing the Owner, ample notice of readiness for inspection of any work ordinarily requiring inspection.

13. SUPERINTENDENCE

The Contractor shall keep on the work, during its progress, a competent superintendent and any necessary assistants, all satisfactory to the Owner. The superintendent shall not be changed except with the consent of the Owner, unless he proves to be unsatisfactory to the Contractor and ceases to be in his employ. The superintendent shall represent the Contractor in his absence and all directions given to him shall be as binding as if given to the Contractor.

14. CHANGE ORDERS TO THE CONTRACT

(a) The Owner, without invalidating the Contract, may order extra work or make changes by altering, adding to, or deducting from, the work, the Contract sum being adjusted accordingly. All such work shall be executed under the conditions for the original Contract except that any claim for extension of time caused thereby shall be adjusted at the time of ordering such change. No changes in the work covered in the approved Contract documents shall be made without having prior consent of the Owner and acceptance by the Contractor of the terms and conditions of the change.

(b) In the event an immediate agreement cannot be reached, the Owner may at any time, by written order, and without notice to the sureties, make changes in the drawings and/or specifications of this Contract and within the general scope thereof. If such changes cause an increase or decrease in the amount due under this Contract, or in the time required for its performance, an equitable adjustment shall be made and the Contractor shall be notified in writing accordingly. Any claim of the Contractor for adjustment under this clause must be asserted in writing within thirty (30) days from the date of receipt by the Contractor of the notification of change, provided, however, that the Owner if he determines that the facts justify such action, may receive and consider, and adjust such claim asserted at any time prior to the date of final settlement of the Contract. If the parties fail to agree upon the adjustment to be made, the dispute shall be determined as provided in Paragraph 15 hereof. But nothing provided in this paragraph shall excuse the Contractor from proceeding with the prosecution of the work as changed. Except as otherwise herein provided, no charge for any extra work or material will be allowed.

(c) Change orders shall be executed in accordance with procedure required by the Owner and no work involving the change shall be done by the Contractor until a copy of the approved change order has been received by him. Verbal change orders may be authorized by the Owner only where loss of life or property appear imminent. Such changes shall further be reduced to writing within a reasonable length of time in accordance with the procedure herein stated.

(d) Change orders will be issued for any change in the contract price, materials used, manner of contruction, or change in completion time. The change in amount of contract price will be determined by the method shown in subparagraph (e) below.

(e) Charges or credits for equipment or work covered by the approved change shall be determined by one or more, or a combination of the following methods at the Owner's discretion:

(1) Unit price bids previously approved. This option shall remain available to the Owner for six months from date of Contract execution.

(2) An agreed lump sum.

(3) The actual cost of:

(a) Labor, including foreman;

(b) Materials entering permanently into the work;

(f) Minor changes and/or adjustments as may be authorized by the Owner involving no change in price shall be verified by a no cost change statement signed by the Contractor.

15. DISPUTES

Except as otherwise provided in this Contract, any dispute concerning a question of fact arising under this Contract which is not disposed of by agreement shall be decided by the Engineer, who shall reduce his decision to writing and mail, or otherwise furnish, a copy thereof to the Contractor at his address shown in the Contract. Such decision shall be final and conclusive unless, within thirty (30) days from the receipt thereof, the Contractor appeals in writing to the Contracting Agent, whose written decision thereon, or that of his designated representative or representatives, shall be final and conclusive upon the parties hereto unless, within thirty (30) days after the receipt thereof by the Contractor, he appeals in writing to a court of competent jurisdiction, which appeal shall operate to vacate said decision of the Contracting Agent. If the dispute is determined by the Contracting Agent, his written decision or that of his representative, or representatives, shall, unless determined by a court of competent jurisdiction to have been fraudulent or capricious or arbitrary or so grossly erroneous as necessarily to imply bad faith, or not supported by substantial evidence, be final and conclusive upon the parties hereto. The Contracting Agent may designate an individual, or individuals, other than the Engineer, or a board as his authorized representative to determine appeals under this article. In connection with any appeal proceeding under this clause, the Contractor shall be afforded an opportunity to be heard and offer evidence in support of his appeal. Pending final decision of a dispute hereunder the Contractor shall proceed diligently with the performance of the Contract and in accordance with the Engineer's decision.

16. RESPONSIBILITY FOR WORK

Neither the final certificates, nor payment, nor any provision in the Contract Documents, shall relieve the Contractor of responsibility for faulty materials or workmanship, and, unless otherwise specified, he shall remedy any defects due thereto and pay for any damage to other work resulting therefrom, which shall appear within a period of one year from the date of substantial completion. The Owner shall give notice of observed defects with reasonable promptness.

17. NON-COMPLIANCE

Acceptance of the work of this Contractor upon completion of the project shall not preclude the Owner from requiring strict compliance with the Contract Documents - that this Contractor complete or correct upon discovery any faulty, incomplete, or incorrect work not discovered at the time of acceptance. The one year limit specified in paragraph 16 shall not void nor limit this requirement.

18. APPLICATIONS FOR PAYMENTS

(a) The Contractor shall submit to the Contracting Agent an application for payment.

(b) No payment can be authorized for equipment or materials not incorporated in the work and not stored on the Owner's property.

19. ASSIGNMENT

(a) Neither party to the Contract shall assign the Contract or sublet it as a whole without the w consent of the other, nor shall the Contractor assign any monies due, or to become due to him hereunder, without the previous written consent of the Contracting Agent.

(b) In case the Contractor assigns all or any part of any monies due to or become due under this C tract, the instrument of assignment shall contain a clause substantially to the effect that: "It is agreed that the right of the assignee in and to, a monies due or to become due to th Contractor shall be subject to prior liens of all persons, firms and corporations for services rendered, or material supplied for the performance of the work called for in this contract."

20. SEPARATE CONTRACTS

(a) The Contracting Agent reserves the right to let other contracts in connection with this work and/or perform work with Owner Forces.

(b) Nothing in the Contract Documents shall preclude the Owner's right to do work on site during th Period this contract is in effect. The Contractor shall afford the Owner access to the site fo purpose of such work.

(c) Normal working day - The Contractors shall carry on the operations during a normal working day of eight (8) hours whenever possible. The General Contractor shall confine their operations on the site to a normal working day beginning and ending at the same time.

21. SUBCONTRACTORS

(a) The Contractor agrees that he is fully responsible to the Owner for the acts and omissions of his subcontractors and of persons either directly or indirectly employed by them, as he is for acts and omissions of persons directly employed by him.

(b) Nothing contained in the Contract Documents shall create any contractural relation between any s contractor and the Owner nor any obligation on the part of the Owner to pay, or to see to the p ment of, any sums to any subcontractor.

(c) No Contractor shall write any subcontract at variance with the conditions of the Contract Documents and the provisions of the Contract Documents shall be incorporated in any subcontract agreement.

22. SPECIAL SAFETY REQUIREMENTS

(a) Fire Protection - Temporary heating devices which are of the open flame type with the exposed fu below the flames and using such fuels as coke, oil, or wood, are strictly forbidden. Temporary heating devices shall not be left unattended while being operated at night or non-work days or shifts.

(b) Grounding of Electrical Equipment - All electrical construction equipment, including portable hand tools and all other apparatus, shall be grounded by a separate ground conductor (other than the service cords) or by a multiple cord containing separate grounding conductor, all in accordar with requirements of the latest edition of the National Electrical Code.

23. OR EQUAL CLAUSE

(a) Where specific material or equipment is named in the specifications, it is understood that other makes of equal size, quality and performance will be acceptable, if approved as equal by the Engineer and the Owner in writing prior to the letting. Requests for such approval must be made to the Owner at least ten (10) days prior to the opening of bids. The approval of material or equipment as equal to that specified will be made in writing in the form of an addendum issued by the Engineer to all plan holders of record. The base bid and any alternate shall be based on materials only as specified or approved.

(b) Should the bidder desire to use materials or equipment in lieu of those specified or approved, he must so state on the proposal form giving the proper deductions or additions as provided for in subparagraph (c) below. The award of the Contract will not be based on the deductions or additions so given. After the Contracts have been awarded the Owner will make the decision regarding the use of materials listed in the proposals.

(c) Where bids are called for the purchase of material, furnishings and equipment of a particular make or kind named in the specifications, the bidders may bid on other makes or kinds of a similar nature but they must name the make and give the name of the manufacturer and a catalogue description and the price of the item on which the bids are based. If the above information is not given, but only price listed, it will be assumed that bidders are bidding on the make and kind named in the specifications and they will be required to furnish that make and kind, at the price listed.

24. MATERIALS AND WORKMANSHIP

(a) Unless otherwise stipulated in the specifications, all workmanship, equipment, materials, and articles incorporated in the work covered by this Contract shall be new and of the best grade of their respective kinds for the purpose.

(b) The Contractor shall, if required, furnish such evidence as to kind and quality of materials. The Contractor shall furnish to the Owner for its approval the name of the manufacturer of equipment which he contemplated installing, together with their performance capacities and other pertinent information.

(c) If not otherwise provided, materials or work called for in this Contract shall be furnished and performed in accordance with well-known established practice and standards recognized by Architects/Engineers and the trade.

(d) Workmen shall be qualified for their respective trade. Laborers shall not be used in lieu of skilled tradesmen for the various crafts.

(e) When required by the specifications or when called for by the Owner, the Contractor shall furnish the Owner for approval, full information concerning the materials or articles which he contemplates incorporating in the work. Samples of the materials shall be submitted for approval when so directed. Machinery, equipment, materials, and articles installed or used without approval shall be at the risk of subsequent rejection.

25. TITLES

Titles to divisions and paragraphs in these Contract Documents are introduced merely for convenience and shall not be taken as correct or complete segragation of the several units of material and labor. No responsibility, either direct or implied, is assumed by the Engineer for omissions or duplications by the Contractor, or his subcontractor, due to real or alleged error in arrangement of matter in these Contract Documents.

26. DEDUCTION FOR UNCORRECTED WORK

If the Owner deems it expedient to accept work injured or not done in accordance with the Contract, an equitable adjustment will be made with a proper deduction from the Contract price for unsatisfactory work.

27. CUTTING AND PATCHING

(a) The Contractor shall do all cutting, fitting, or patching of his work that may be required to make his several parts fit together or to receive the work of other Contractors shown upon, or reasonably implied by, the Plans and Specifications for the completed project and he shall make good after them as may be directed by the Owner or Owner's representative.

(b) Any cost caused by defective or ill-timed work shall be borne by the party responsible therefor.

(c) The Contractor shall not cut, dig, burn, weld to or otherwise alter or modify the work of any other Contractor without the consent of the Engineer or his representative. The above is particularly applicable in reference to structural members and finished surfaces.

(d) All cutting, fitting, or patching shall be accomplished by only skilled tradesmen in their respec tive craft area.

28. SALVAGED MATERIAL

All salvaged material shall remain the property of the Owner unless specifically stated otherwise in the Specifications.

29. PROGRESS CHART, PROGRESS OF WORK, CONTRACT TERMINATION

(a) The Contractor shall within five (5) days, or within such time as determined by the Engineer, aft date of commencement of work, prepare and submit to the Engineer for approval a practicable and feasible schedule, showing the order in which the Contractor proposes to carry on the work, and t date on which he will start the several salient features (including procurement of materials, plant and equipment) and the contemplated dates for completing them. The schedule shall be in th form of a progress chart of suitable scale to indicate appropriately the percentage of work scheduled for completion at any time. The Contractor shall enter on the chart the actual progres at the end of each week or at such intervals as directed by the Engineer, and shall immediately deliver to the Engineer four (4) copies thereof, two of which shall be retained by the Owner for filing and posting.

(b) The Contractor shall furnish sufficient forces, construction plant, and equipment, and shall work such hours, including night shifts, overtime operations, and Sunday and holiday work, as may be necessary to insure the prosecution of the work in accordance with the approved progress schedule. If, in the opinion of the Engineer, the Contractor falls behind the progress schedule, the Contractor shall take such steps as may be necessary to improve the progress and the Engineer may require him to increase the number of shifts, and/or overtime operations, days of work, and/or the amount of construction plant, all without additional cost to the Owner.

(c) Right of the Owner to Terminate Contract - In the event that any of the provisions of this Contract are violated by the Contractor, or by any of his subcontractors, the Owner may serve written notice upon the Contractor and the Surety of its intention to terminate the Contract, and unless within ten (10) days after the serving of such notice upon the Contractor , such violation or delay shall cease and satisfactory arrangement of correction be made, the Contract shall, upon the expiration of said ten (10) days, cease and terminate. In the event of any such termination, the Owner shall immediately serve notice thereof upon the Surety and the Contractor, and the Surety shall have the right to take over and perform the Contract, provided however, that if the Surety does not commence performance thereof within ten (10) days from the date of the mailing to such Surety of notice of termination, the Owner may take over the work and prosecute the same to completion by Contract or force account, for the account, and at the expense of the Contractor, and in such event the Owner may also take possession of and utilize, in completing the work, such materials, appliances, and plant as may be on the site of the work and necessary therefor and the Contractor and his Surety shall be liable to the Owner for any and all excess cost occasioned thereby.

30. BREAKDOWN OF CONTRACT PRICE *

The Contractor shall submit on forms provided by the Owner:

(a) A detailed estimate giving a complete breakdown of the Contract price and
(b) Periodic itemized estimates of work done for the purpose of making partial payments thereon.
(c) The costs employed in making up any of these schedules will be used only for determining the basis of partial payments and will not be considered as fixing a basis for additions to, or deductions from, the Contract price. Omission by the Contractor for any item, device or equipment on this listing shall not relieve the Contractor from furnishing same when required to do so either in the plans or specifications.

31. ERRORS OR OMISSION

(a) If the Contractor discovers any error or omission in the Contract drawings or specifications or in the work undertaken and performed by him, he shall immediately notify the Engineer and the latter shall promptly verify or correct the same. The Contractor's notification shall be in writing and copy of his transmittal shall be forwarded to the Owner.

(b) If, knowing of such error or omission and prior to correction thereof, the Contractor proceeds with any work affected thereby, he shall do so at his own risk and the work so done shall not be considered as work done under the Contract and in performance thereof unless and until approved and accepted.

32. TESTING OF EQUIPMENT AND ALL CONSTRUCTION

(a) When notified by the Contractor that, in his opinion, all work required by the Contract has been completed, the Engineer shall so notify the Owner and request a date for the final inspection of the work, including any test of operation. The Engineer, accompanied by the Owner, shall make a final inspection of the work including any test of operation. After completion of this inspection and these tests, the Engineer shall, if all things are satisfactory, issue to the Owner and the Contractor a certificate of final completion certifying that, in his opinion, the work required by the Contract has been completed in accordance with the contract drawings and specifications. However, the certificate shall not operate to release the Contractor of his sureties from any obligations under the Contract or the Performance Bond, or from any guarantees, warranties, or maintenance bonds required in the Contract Documents.

(b) The Engineer and the Owner shall be permitted access to the project at all times for the purpose of making inspections and tests of the materials and equipment. The Contractor shall provide necessary assistance to the Engineer and Owner to perform all necessary operation and quality tests on the site. The Contractor will not be required to furnish personnel for tests conducted off the site.

(c) All materials and equipment used in the construction of the project shall be subject to adequate inspection and testing in accordance with accepted standards. The laboratory or inspection agency shall be selected by the Owner. The Owner shall pay for all laboratory inspection service direct and not as part of the Contract.

(d) Materials of construction, particularly those upon which the strength and durability of the structure may depend, shall be subject to inspection and testing to establish conformance with specifications and suitability for uses intended.

33. TIME FOR COMPLETION AND LIQUIDATED DAMAGES

It is hereby understood and mutually agreed, by and between the Contractor and the Owner, that the date of beginning, rate of progress, and the time for completion of the work to be done hereunder are essential conditions of this Contract; and it is further mutually understood and agreed that the work embraced in this Contract shall be commenced within ten (10) calendar days after date of issuance of the notice to proceed.

34. OWNER'S RIGHT TO WITHHOLD CERTAIN AMOUNTS AND MAKE APPLICATION THEREOF

The Contractor agrees that he will indemnify and save the Owner harmless from all claims growing out of the lawful demands of subcontractors, laborers, workmen, mechanics, materialmen, and furnishers of machinery and parts thereof, equipment, power tools, and all suppliers, including commissary, incurred in the furtherance of performance of this Contract. The Contractor shall furnish satisfactory evidence that all obligations of the nature hereinabove designated have been paid, discharged, or waived. If the Contractor fails so to do, then the Owner may, after having served written notice on the said Contractor, either pay unpaid bills, of which the Owner has written notice, direct, or withhold from the Contractor's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged, whereupon payment to the Contractor shall be resumed, in accordance with the terms of this Contract, but in no event shall the provisions of this sentence be construed to impose any obligations upon the Owner to either the Contractor or his surety. In paying any unpaid bills of the Contractor, the Owner shall be deemed the agent of the Contractor, and any payment so made by the Owner, shall be considered as payment made under the Contract by the Owner to the Contractor and the Owner shall not be liable to the Contractor for any such payment in good faith.

35. MUTUAL RESPONSIBILITY OF CONTRACTORS

If, through acts of neglect on the part of the Contractor, any other Contractor or any subcontractor shall suffer loss or damage on the work, the Contractor agrees to settle with such other Contractor or subcontractor by agreement or arbitration if such other Contractor or subcontractor will so settle. If such other Contractor or subcontractor shall assert any claim against the Owner on account of any damage alleged to have been sustained, the Owner shall notify the Contractor, who shall indemnify and save harmless the Owner against any such claim.

8.4.4 STANDARD PARAGRAPHS: SCOPE OF WORK

The Scope of Work (SOW) section of the final negotiated contract is that section of the purchase order specifying the detail requirements which the vendor agrees to supply. The SOW includes, to the degree applicable, at least the items covered in the following standard paragraphs. Also, an essential portion of the SOW are detailed equipment, installation and service specifications. For example, when a bidder responds to an installation IFB, he describes the equipment (manufacturers, model numbers, etc.), materials (type manufacturer, quantities, etc.), hardware (coaxial line and connectors, waveguides, etc.), and types of labor resources to be used; and these displays must become part of the final purchase order. For complex purchases, the SOW must be extended into greater detail by an architect or engineer. Be sure to include all applicable specifications in this section of the control.

NOTE: Those paragraphs marked with an asterisk (*) require information to be added or other consideration when preparing the contract.

The SOW should include:

1. CONTRACTOR QUALIFICATIONS *

If requested by the Owner, the Contractor shall furnish evidence satisfactory to the Owner that the Contractor has the necessary facilities, ability and financial resources to perform the Contract. He shall also furnish a list of previous projects of this type and size which have been completed. He shall furnish evidence of his ability to provide maintenance service for the equipment supplied.

2. STANDARDS

All equipment shall be designed, built and tested and installed to comply with recognized standards established by:

(a) American Standards Association (ASA)
(b) American Society of Testing and Materials (ASTM)
(c) Institute of Electrical and Electronic Engineers (IEEE)
(d) National Electrical Manufacturers Association (NEMA)
(e) National Board of Fire Underwriters Code (NECP)
(f) Electronic Industries Association (EIA)
(g) Radio-Electronics-Television Manufacturing Association (RETMA)
(h) CCIR and CCITT
(i) Federal Communications Commission (FCC)
(j) Federal Aviation Association (FAA)
(k) Occupational Safety and Health Act (OSHA)
(l) Underwriters Laboratories
(m) Applicable State and Local Codes

Where minimum standards or performance criteria are set forth, no compromise of these standards or performance criteria will be considered. Where specified standards are not mentioned, the bidder will be expected to incorporate equipment and methods consistent with reliability and performance elsewhere specified.

3. DEVIATIONS *

Deviation from full compliance with these specifications requires approval of the Engineer. The Supplier shall furnish a formal request in writing for each deviation providing substantiating reasons for the deviation request. The request shall be sent to (specify).

4. ITEMS TO BE FURNISHED BY OWNER *

(List all items such as electrical power at site, access, specific drawings, or other data, parking, licenses, and permits, etc.)

(a) 120/240 VAC electrical power at each site
(b) Right of way, site access, roads, driveways, easements
(c) Data on existing conditions and equipment to be used or connected to. Access areas will be defined.
(d) Parking area, and place for employees of the contractor to clean up at the end of the work day.
(e) Licenses

5. MAJOR ITEMS TO BE PROVIDED BY BIDDER

(a) This project shall include, but is not necessarily limited to, providing all items detailed on the bid price list. All other items required shall be furnished and installed to provide a complete functional system as intended by these specifications.

(b) In addition, the Contractor shall provide the following services:

(1) Perform all field surveys and tests required for equipment and system design.
(2) Furnish, install, test and place the system in service.
(3) Instruct (on an informal basis during installation and testing) the owner personnel in equipment operation and minor maintenance.
(4) Provide necessary equipment and perform tests to prove equipment is performing as specified. Tests shall be conducted at time specified and in presence of the Engineer.
(5) Furnish all labor, materials, equipment and appliances for the system in accordance with these specifications.
(6) Provide written record of such tests to the Owner including, but not necessarily limited to transmitter r.f. power output, receiver sensitivity, frequency, transmitter modulation and any other parameters indicative of Contract compliance or required by FCC.

6. REPORTING *

For services, it is common to require that periodic progress reports are to be supplied by the vendor. For example, a system installation contract should call for at least monthly progress reports complete with a description of work completed, activity schedules, problems encountered and goals for the subsequent period. The lack of adequate progress reporting by vendors, as applicable, can lead to many problems in terms of the purchasing agency having insufficient information to judge whether suitable progress is being made, and thus losing the ability to take remedial action in time to avoid schedule delays.

7. UTILITIES

All water and electricity necessary for the construction of work specified hereinafter shall be furnished by the Contractor except where these utilities are readily supplied by the Owner.

8. EXAMINATION OF SITE

The Contractor shall visit the premises, carefully examine same to familiarize himself with existing conditions at the time of submitting his proposal as no claim for extras will be allowed for any work which could have been foreseen by the Contractor and included in his proposal at the time of submitting same.

9. SCHEDULE OF WORK

The Contractor shall so schedule the work as to not interrupt the daily routine of the other functions in the buildings in which work is to be done and shall coordinate with the proper authorities.

10. STORAGE OF MATERIALS

The Contractor shall provide for storage of materials, any materials stored outside shall be properly protected from the weather and shall be located in areas approved by the Engineer.

11. PROTECTION OF EXISTING BUILDINGS AND SERVICES

The Contractor shall be responsible for damages to the existing buildings, equipment and services during construction. Should any damage occur the Contractor shall replace or repair to the satisfaction of the Engineer.

12. SPECIFIED EQUIPMENT

(a) Where equipment is specified by trade or type name, only those brands or types mentioned will be used in the Base Bid, and if a Contractor wishes to quote on an equal type of equipment to that specified, he may do so on an alternate basis. The low bidder will be determined on the basis of the base bid and any "asked for" alternate; any write-in alternates will not be considered in determining the low bid.

(b) When an item of material or equipment is specified as to make, size, shape, operating characteristics, and capacities, etc., and other brands are mentioned as acceptable equal, the other brands must conform to all requirements of the specifications and it shall be the Contractor's responsibility to verify the other mentioned brands do meet the requirements of the specifications.

(c) These specifications do not include any proprietary items, components, circuits or devices which would preclude any equipment manufacturer from producing equipment to meet these specifications. All technical tolerances, ratings, power outputs or any technically specified criteria contained within these specifications are considered to be within the current state of the Electronic art and are currently being met by commercially available equipment. The fact that a manufacturer chooses not to produce equipment to meet these specifications , providing the above criteria are met, will not be sufficient cause to adjudge these specifications as restrictive. Should any of the above criteria not be met within these specifications as to cause or portion of these specifications to be proprietary, the Owner shall be advised immediately.

13. LICENSING

Contractor shall provide Owner with technical data necessary for preparation of application for necessary permits and licenses for the system and shall assist in preparation of applications for same.

14. SURVEYS

(a) Provide all surveys, field tests and other investigative work required for verification and relocation of applications for same.

(b) Provide Engineer for four (4) copies of reports of such investigations.

15. INSTRUCTION MANUALS AND PARTS LISTS

(a) Furnish prior to final acceptance three complete and final copies including corrections and revisions to the system occuring during installation and test for each installation. One manual of each type shall be furnished to the Engineer. Instruction manuals are to include the following information:

(1) Summary: Technical summary of the equipment including power output, power input, frequency range, etc.

(2) Safety Notice: A safety notice shall be prominently displayed and shall indicate all safety precautions to be taken by personnel and employed in the installation or maintenance of the equipment.

(3) Operational diagram of system as constructed (block) showing all pieces of equipment.

(4) Specifications for each station of the system.

(5) System drawings, comprising detailed drawings applicable to the system and showing connection points for Owner wires and power supply terminations.

(6) Parts list with identification symbols or part numbers for all replaceable parts and assemblies. Parts lists shall include technical description of parts to aid in ease of procurement.

(b) The text of the instruction book shall include:

(1) Description: Which shall contain a general description of the unit followed by a detailed description discussion of the mechanical construction and electrical theory of operation of the subject unit.

(2) Installation: Which shall cover the installation of the subject unit. It shall contain instruction for unpacking, positioning, and wiring the unit and the installation and wiring of any separately crated components, and optimization of system performance.

(3) Operation: Which shall outline and describe in detail all adjustments, checks, and tests required to place the subject unit in a satisfactory operation. Instructions and information regarding the limitations of the equipment shall be given, especially in connection with components likely to be damaged by improper adjustments.

(4) Maintenance: Which shall be devoted primarily to maintenance of the equipment and shall give detailed instructions for its inspection and repair. A table shall be included showing routine inspections and tests which are required to assure continuity of service. This section shall contain a list of possible troubles, together with their remedies, and a table of the normal voltages and currents for various items, over their normal range of operation. The instruction book shall contain a complete list of all parts for the subject unit including such minor items as sockets, terminal strips, etc. This list shall be made up in tabular form and contain:

The item number corresponding to diagrams furnished (such as C-1, G-1, L-1, etc.). A description of the item rating where applicable, and a statement of its function such as (capacitor, 5.5 mmfd, 400 volts, bypass). For standard parts which Contractor has purchased, the data given shall be sufficient to permit ordering replacements from the manufacturer, including a minimum, part symbol, name of part and its function, manufacturer's rating, name and address of manufacturer and his type designation. Diagrams shall be included in the instruction book as follows:

-Schematic diagram of each unit module
-Schematic diagram of each unit or module which uses a printed circuit board shown as an overlay on a pictorial representation of the printed circuit board, both sides.
-Schematic diagram of all control circuits
-Schematic diagram of interconnections of units or modules
-External connection diagram for each type of installation
-Item designations corresponding to the parts list shall be shown on all drawings
-Calibration charts of all controls and adjustments where such calibrations are necessary to proper maintenance of the equipment
-Mechanical details of any special mechanisms employed in the equipment
-Block and level diagram indicating all voltage or current levels

(c) Bind each Instruction Manual in durable cover including a folder envelope for drawings.

(d) In addition to schematics, etc., the manuals shall contain theory of operation of all active devices in sufficient detail to facilitate servicing. The bidder shall include a bid sample of complete manuals from an installation of similar size and scope for the purpose of evaluation. The manuals will be returned.

16. CLEAN UP

Remove from buildings and sites as it accumulates, all containers and debris resulting from this Contract work and leave all materials and equipment and spaces occupied by them absolutely clean and ready for use.

17. TEST AND INSPECTIONS

(a) The Contractor shall put all equipment into satisfactory operation and perform all work as necessary for tuning, adjusting, etc. required for satisfactory operation.

(b) Tests and inspections may be conducted at any time at the Owner's or Engineer's discretion to determine the characteristics of the system herein described. Contractor shall assist in such tests and inspections as necessary through provision of equipment and access to various connections, devices, and in general all equipment, in addition to demonstrating operating features of all components.

(c) Contractor and manufacturer shall perform shop tests prior to shipment of equipment. The Engineer shall be notified of shop tests two weeks in advance and shall be permitted to witness all tests. This shall include assembly of all equipment inmanufacturer's plant and testing of all circuits to assure proper functioning of all equipment and meeting performance specifications. Certified data of tests shall be submitted to the Engineer.

(d) Contractor shall make all tests, inspections, and checks necessary to place equipment in operation and to determine that system functions satisfactorily.

(e) Contractor shall notify Engineer when installation is considered to be complete, in operating condition and ready for operation and performance tests.

(f) In presence of Engineer, Contractor shall conduct complete functional performance tests of system to demonstrate that system meets performance guarantees. Data recorded during these tests shall be checked against that obtained during shop tests. All instruments to be furnished by Contractor. Owner will not accept work nor make final payment to the Contractor until Contractor has proven to the Engineer beyond a reasonable doubt that the system furnished and installed by the Contractor is operating in conformance with specifications.

18. GUARANTEE

(a) The Contractor shall guarantee all materials, workmanship, and the successful operation of all equipment (except tubes) and apparatus installed by him for a period of one year from date of final acceptance of the whole work unless indicated for a longer period of time. If any defect or malfunction occurs within the first three months following acceptance, the Contractor shall repair or replace the defective unit at his sole cost and expense. The guarantee for the subsequent nine months of the year following acceptance, shall be limited to replacement of parts, complete modules, circuit boards and individual component at no cost to the purchaser, for any labor, equipment or transportation, replacement parts, or any other charge.

(b) Transistors and diodes shall be guaranteed for a minimum of one year. Tubes shall be warranteed for a period of ninety (90) days.

(c) If it appears that within one year from date of completion the equipment does not meet the warranty specified above including repeated failures of the same component or unit, the vendor shall thereupon correct any defect, including non-conformance with the specification and at its option either by repairing or replacing any defective part or parts. The Contractor shall respond to a trouble call within twenty-four (24) hours of receipt of the call. The Contractor may provide a replacement unit for use until repairs and re-installation are completed.

(d) The Contractor shall warrant to the buyer that the equipment to be delivered shall conform to the specifications and be free from defects in materials and workmanship. The foregoing warranty is exclusive of all other warranties whether written, oral or implied.

(e) In addition the Contractor shall guarantee the system for following conditions:

(1) Free from imperfections in design, materials, or construction which would create hazards, operating difficulties, or failure to meet specified performance quality.

(2) Capable of continuous and satisfactory performance under normal operating conditions as specified equipment rating and capacity.

(f) The Contractor shall provide upon request evidence of the intent of the manufacturers to make available replacement parts for each item included in this equipment and shall be in a position to promptly replace these parts or provide information for substitute parts as may be required for a period of ten (10) years.

(g) The Contractor shall, on combining the equipment supplies with the materials and services provided by the Owner gurantee a completely operational system to the extent that the bidder supplies the equipment.

19. EQUIPMENT DESIGN

The equipment provided shall be of rugged construction and designed with the best engineering practices and incorporate the latest technical developments. All equipment and materials supplied must be new.

20. SYSTEM DESIGN

The Contractor shall be responsible for providing equipment which performs within the system to the specification outlined in this document. The Contractor shall furnish and install the equipment supplied and demonstrate that it is compatible and the system performance in accordance with these specifications.

9.0 TECHNICAL IMPROVEMENTS

All types of communications are affected by technology advances. Recent law enforcement communications improvements have resulted in the increasing use of UHF channels, speech scramblers, data communications (both base-to-mobile and mobile-to-base) etc. Although not all of these have found wide usage, many are becoming more important as the equipment improves and becomes more cost effective.

Two recent developments which may find wide application in law enforcement and other public safety work are computer-aided-dispatch and automatic-vehicle-monitors. The current status of these developments is discussed in the following section.

9.1 LAW ENFORCEMENT INFORMATION SYSTEMS

There is an increasing flow of information from local,state and national law enforcement records files. Much of the information now is handled by manual retrieval from files of aperture cards, microfiche and printed lists. Recent developments in integrated data systems have resulted in the NCIC data system, TRACIS (Iowa), LEADS (Illinois), LEIN (Michigan) and other state-wide systems. Automatic information systems are now appearing,involving the use of computers for automatic file entry and retrieval via time-shared terminals. Several large cities are extending this concept in use of automatic command and control system and with the aid of major vendors are experimentally evaluating these for operations.

Several of these have been studied as they could apply to the agencies in Iowa. Several of the larger coordinated city and county agencies could benefit from the usage of these systems if they were designed to have the proper size and capacity. The technology is ready but the software and system hardware capacity needs to be developed suitable for Iowa Law Enforcement Agencies and proof tested in one or more of them before general usage commences.

The recommended procedure to obtain this development incolves encouragement of one or more agencies (which have an experimental interest) to develop grant request proposals which will partially fund this activity. Accordingly, the following functional description is provided to list features which should be sought in a system design. The design of such a system is beyond the scope of this contract, however, major vendor systems were reviewed in preparation of the following list which provides a basic funcational capability required of the system:

1. Files:
   a. Wanted persons
   b. Wanted vehicles, possibly as part of a complete county vehicle registration file
   c. Stolen property
   d. Crime statistics
   e. Dispatch activity, incident files, etc.
   f. Modus operandi, a major crime record comparison and matching process
2. Functions:
   a. Person/vehicle/property search for local area wanted or stolen as appropriate,
   b. Incident status and reporting. Provide status of incidents as they are reported into the system, when the dispatcher assigns a unit, when the unit reports 10-23 and 10-24, and when the incident is closed. A desired optional feature is the capability to ascertain whether the same incident has been reported by more than one person. As incidents are reported, the computer can search them for similarities and report these similarities to the dispatcher,
   c. Prior incident search. This feature enables the dispatcher to ascertain whether an incident has occurred at the same address or at the resident corresponding to given name. This information is also essential to preparing crime reports and statistics,
   d. Automatic dispatch. This feature automatically keeps a record of the current status of all units. It displays the numbers of the available units in a given patrolled district or area to the dispatcher so that he can dispatch the nearest unit to a complaint. It also maintains records on available vehicles in adjacent patrolled districts in the event that all of the units in the district in which the incident occurred are out of service. Eventually, with the advent of reliable automatic location devices, routine dispatch could be automatic,

e. Uniform Crime Reporting. This feature allows the automatic development of uniform crime reports,

f. General - A law enforcement system should be flexible and open-ended so that programmed features can be added at any time.
   - It should provide sufficient bulk storage to accommodate the required files.
   - The software should be portable, that is, written in a common language (e.g. COBOL) such that it can be used on different computers, with no, or at most, very little re-programming.
   - It should be a large enough system to accommodate ten years projected growth with use of expansion capability.
   - It should provide rapid access to information and provide processing speed so that response to any inquiry comes back within a few seconds (15 or less).
   - It should be secure from access by agencies other than law enforcement agencies for which it is intended.
   - It should be able to accommodate an eventual mobile terminal system (terminals in the vehicles).
   - Its reliability should be very high (well over 99%, 95% of the time) with backup equipment on line for major system functions.

The desired features of any law enforcement system must be carefully considered, their relative costs weighed, and general specifications for the system should be drawn up by the user agency, perhaps with the assistance of an independent consultant. It must be recognized that specifications for a computer system are vastly different from those of a communications system. The reason for this is,that computer systems are controlled by programs (software) and it is very difficult to write adequate software specifications. None-the-less, we recommend that independent, non-restrictive specifications be drawn for a system; that vendors be asked to bid on developing the system based on those specifications; and that the system specified be a turn-key system, that is, payment for the system is made when the system is delivered, documented, tested on-line and meets all specifications when operated by agency personnel who have been instructed in vendor training sessions.

9.2 AUTOMATIC VEHICLE MONITORS IN LAND MOBILE SYSTEMS (Reference 30)

Rapid geographical vehicle location and automatic electronic display of this location requires a public safety communications subsystem. This subsystem is comprised of a sensor which provides location data, a communications link to transmit these data to the Comm Center, a data processing device and a method of displaying the information in geographical terms for use by the Comm Center dispatcher.

Automatic vehicle monitors (AVM) or vehicle locators have been discussed with state, county, and municipal law enforcement officials both inside and outside of Iowa. Reactions varied from "may be useful" to "would have great utility"! Estimates for the desired vehicle location accuracy varied from 100 feet to one mile. An average was 500 feet for metropolitan areas and 0.5 miles in rural areas. Officials generally view such a system, when it becomes economically feasible, to provide considerable help in rapidly selecting the vehicle to respond to a given call, in speeding aid to an officer in difficulty, and enabling better supervision of patrols. Several mentioned that unless such supervisory applications were handled properly, some officers might take offense at their every movement being observed. One supervisor mentioned in this connection that "any officer who was doing his job would have no worries". A positive and recognized advantage derives from an ability to send aid to an officers location should he become troubled or attacked with no way to report his condition.

9.2.1 AVM BENEFITS

The use of an automatic vehicle monitor in public safety vehicles, especially, those used for law enforcement patrol units has several potential benefits. These include:

1. A reduction in overall unit response time by assuring that the dispatcher can locate and dispatch the closest available unit in each case. Reduce the number and length of radio messages associated with the emergency response. Both of these have an effect in reducing the response time to an emergency request,

2. Command and dispatch personnel can more effectively monitor the status and location of all patrol units. This will significantly increase an ability to control the deployment of needed resources and manpower.
3. The use of a central processor controlled real-time display of unit location will allow storage of data and enable generation of activity summaries for any period of operation of the unit,
4. Patrol patterns can be made more random and dispatched to suit the occasion rather than to have a predetermined and/or fixed patrol pattern since the command and dispatch will be able to monitor continously the vehicle distribution in a patrol district,
5. Automatic non-voice status reporting devices will enable command personnel to be alerted immediately when a patrol unit needs assistance and will enable the assistance to be directed precisely to its destination,
6. Communities or operating Comm Centers for regions, districts or communities in a network will be able, through centralized computing, to determine all the vehicle locations in the network and provide, therefore, a location service function for that area. This function provides the real-time information needed for computer-aided-dispatch or automatic command and control systems.

9.2.2 FUNCTIONAL REQUIREMENTS

Some basic functional requirements and parameters that must be determined for an AVM subsystem are as follows:

1. Area of coverage, jurisidictional area of agency,
2. Accuracy by which a vehicle may be located within the area of coverage. (Note less than $\pm$ 500 feet in urban areas and $\pm$ 2500 feet in rural areas),
3. Number of vehicles that can be served from the largest to smallest agency,
4. Frequency of vehicle polling each time called:
   a) during normal operations
   b) during priority operations,
5. Frequency of location sensor measurements. Continuous (i.e. $<$10 second period),
6. Data transmission rate. Data may be interspersed with voice on either Information or Operation Channel of mobile radio unit,

7. Passive location sensor (no action by vehicle occupants),
8. Sensor signal source (operational, reliability, maintenance, use by other services, amount of spectrum used, etc.),
9. Data processor (small unit at public safety Comm Center),
10. Display at Comm Center dispatch console,
11. Cost for mobile vehicle sensor should be less than a standard mobile radio),
12. Mobile readout of coordinate position (optional).

9.2.3 TYPES OF AVM SYSTEMS

The types of AVM systems fall in three (3) general categories:

1. Inertial navigation (dead reckoning),
2. Proximity (signpost or check-in). Location grid of node and number from check points,
3. Triangulation or trilateration (radio location).

Inertial Navigation Systems

The inertial navigation system uses equipment completely contained in the vehicle to determine its location. The distance and direction of travel are monitored by this equipment so that the position of the vehicle is known at any time. These location data are transmitted to a Comm Center upon receipt of a request.

Although inertial navigation systems have been developed and are currently in use in aircraft, no known AVM system using this principal has been tested. The primary reason is high cost, for a gyro platform is needed in each vehicle. This is very expensive (estimated at $10,000). A periodic update method is required for reset of inherent drift inaccuracies. For reliability, the reset should be automatic and either continuous or be provided each 15 to 30 minutes. This requires either a manual or automatic input of a secondary location monitor.

Proximity Systems

Three (3) known systems of this type, (a) the RCA Electronic Fence (Reference 27, (b) the Motorola CTA (Reference 28) and (c) the Passive Signpost (Reference 26), have been proposed and tested.

a) In the RCA system a grid or array of transmitters emit location codes which are received and stored in the vehicle as it enters a particular geographical "zone". When a data request is received by a vehicle from the Comm Center, the vehicle identification code and the current location code are transmitted to the Comm Center for display.

Thus, the dispatcher knows the geographical "zone" inside of which the vehicle is located. The accuracy of location is thus determined by the size of the zone. The estimated number of transmitters necessary to cover an area of 100 square miles with an accuracy of 500 feet is between 10,000 and 20,000. The RCA test system operates with an amplitude modulated carrier at 10.6 GHz and uses a 10 bit message at 100 bps. This enables the system to have 512 zones and is readily expandable.

b) The Motorola system was built and tested for use in Chicago Transit Authority buses. It used fixed location "signposts" which transmit on 150 MHz (nominal) using 100 milliwatts output power and a 12.5 kHz bandwidth. A 10-bit digital code, which represents the signpost location is transmitted and detected by a bus receiver as it passes a signpost. Data is stored in a receiver memory. Each time the bus passes a new signpost, the data in memory is up-dated. The buses are interroqated by the base station on a polling cycle and respond on a 25 kHz bandwidth channel operating at 450 MHz (nominal). The system has a capacity of 3,300 buses with an up-date period of 5 minutes. The system accuracy at the 95 percentile point in a metropolitan high-rise environment is estimated at 500 feet. No careful accuracy evaluation has been reported.

c) A truely "signpost" AVM system involves the use of a passive tune circuit reflector which is part of an ordinary street sign. Individual high-Q elements operating in the microwave bands are made a part of the street sign. The discrete frequencies to which the elements are tuned are made a part of the "printed circuit street sign" and are individually selected for each different intersection.

Each vehicle contains a pulsed microwave transmitter which sweeps through a specific range of microwave frequencies in sequential bursts. When the vehicle approaches the coupling range of the "signpost", those frequencies in the swept spectrum at which the tuned circuits are resonant are re-radiated. These are detected in time sequence by the microwave receiver in the vehicle and provide the necessary data to identify that location. These data are stored in a register together with vehicle identification and are transmitted to the base station upon request. A computer is used to process these data and identify the location of the vehicles.

It is not known if a system of this type has been tested. The number of "signposts" required would depend on needed accuracy of a vehicle location.

<u>Trilateration Systems</u>

Several systems, which can generally be classified under radio location using trilateration or triangulation, have been either tested or proposed. All such systems use some form of time or phase (i.e.; distance) difference measurements and these measurements establish the vehicle location by means of rectangular, polar, circular, or hyperbolic coordinate systems. These systems have different operational features, performance capabilities and limitations. Each requires a data processor in the Comm Center, and covers the frequency spectrum from 10 kHz to 100 GHz. The following are brief descriptions of systems:

a) Hazeltine System (Reference 28)

The Hazeltine system is a wide-band pulse ranging system operating in the 902-928 MHz band. It employs a hyperbolic ranging algorithm so that only the return transmission from the vehicle is used for ranging. Modest data transfer is provided between base station and vehicle during each location up-date which occurs in a time-slot assigned to each vehicle. Approximately 4,000 vehicles can be accommodated every 15 seconds in a "high-rise" environment with a demonstrated accuracy of 300 feet.

(b) The Cubic Corporation System (Reference 28)

The Cubic AVM system is operated at 220 MHz and uses phase trilateration and includes the usual voice channels and a two-way digital link between the base station and the vehicles. The data link uses a digital link overlay technique and operates at 3840 Hz and a rate of 240 bits/sec. Low priority vehicles are polled four (4) times per minute and high priority vehicles are polled sixteen (16) times per minute. The vehicles are divided into four (4) low priority groups and one high priority group. The base station transmits a tone for trilateration purposes and can obtain data from approximately 1000 vehicles per minute. The system location accuracy in a "high-rise" environment is approximately 5000 feet and in a low-rise environment 3400 feet.

(c) Sierra AVM System (Reference 28)

The Sierra system uses phase trilateration on a 1.5 kHz tone transmitted by each vehicle for 10 milliseconds on the regular mobile transceiver. The signal is received by several satellite receiving stations, demodulated with the audio transmitted to the base station via dedicated telephone lines. The system will determine the vehicle location in a "high-rise" environment with an accuracy of 2700 feet and in a "low-rise" environment with an accuracy of 4500 feet. Two 25 kHz channels will accommodate 1,360 fixed route or 680 random route vehicles. In order to achieve a location accuracy of 500 feet, it is estimated that 28 receiving stations will be necessary to cover an urban area of 100 square miles.

(d) The Teledyne AVM System (Reference 28)

The Teledyne AVM system uses the U.S. Coast Guard Loran-C navigation system operating at 100 kHz and as a consequence no additional spectrum allocation is necessary. A Loran-C receiver is used at the base station and in each vehicle.

The time difference data from each vehicle is transmitted to the base station and the Comm Center processor determines the vehicle location. An accuracy of 500 feet is claimed for the system with recorded accuracies of 1,400 feet and 1,000 feet being measured in a "high-rise" and "low-rise" environment respectively in the Philadelphia area.

At the present time, the Loran-C ground-wave propagation, which is capable of providing a location fix with 1,500 feet accuracy contours, 95% of the time and a standard deviation of 0.1 microsecond, covers only the Eastern one-third of the continental United States (East Coast, Southern Coast, and the Great Lakes from Wisconsin east). Skywave fix area, which covers the remaining area to the Rocky Mountains provides an accuracy of only two nautical miles per microsecond. Consideration is now being given to installing Loran-C stations to provide west cost coverage but North Central States and portions of the Southwest will not be covered by stations currently planned for installation through the year 1980.

(e) TV Time System (Reference 29)

The National Bureau of Standards Boulder Laboratory has proposed and tested the basic concepts of an AVM system which uses time synchronized scan signals from nearby TV stations. The basic time difference data is measured in each vehicle and these data can be transmitted to a Comm Center on an existing radio channel for processing and display. Results show that the system is capable of a location accuracy of better than 60 meters (200 feet) with a 95% confidence level.

After time synchronization of TV stations is implemented, the TV stations become passive participants in the system. However, the use of local TV stations in this system presents a problem because the stations do not ordinarily operate twenty-four hours per day. In addition, TV stations are not necessarily uniformly distributed around a metropolitan area. These complications could be eliminated with auxiliary stations constructed specifically for this purpose but this removes some of the economic and spectrum advantages to this system. The cost of AVM equipment per vehicle has been estimated to be between $500 and $1,000. This doesn't include the cost of the processor and display units at the Comm Center.

(f) Omega System (References 31, 32, 33 and 34)

The Omega navigation system, when fully implemented in late 1975, will provide world-wide navigation. Eight (8) transmitters will each radiate 10 kilowatts of rf energy on 10.2, 11.33 and 13.6 KHz in synchronized 1 second (approximately) time slots which comprise a 10 second time frame.

These signals are currently used for maritime and aircraft navigation and have positioning accuracy ranging from approximately 660 feet to 6600 feet (one nautical mile). They could be used for AVM, although no known system has made application of these signals for this purpose. In a system of this type a passive receiver in the mobile would determine the phase difference between the received signals and an internal frequency standard. The phase data would then be automatically transmitted in digital form to the Comm Center on the Information Channel whenever the Comm Center requested it. At the Comm Center these data when compared with similar data received at that location and adjusted for diurnal variations of the ionosphere (due to the rising or setting of the sun). The Comm Center computer can then calculate and display the location of the mobile. It may be expected that this differential system could have accuracy better than the primary positioning necessary and its cost should be considerably lower than when primary position fixing is done within each vehicle.

9.3 RECOMMENDATIONS

The AVM state-of-the-art is evolving relatively slowly and has not approached a point where one or more system types have become predominate. System cost estimates are very difficult to obtain as some manufacturers are waiting for firm frequency allocations to be made by the FCC for AVM applications. Therefore, it is recommended that no general implementation of AVM's in Iowa Public Safety Communications be undertaken at this time. However, it may be considered desirable for concerned officials in some locations, e.g. Des Moines and Polk County or the Highway Patrol to obtain funding of a research model installation of one of the AVM systems described above.

10.0 RECOMMENDATIONS

The following recommendations are prepared for guidance of those individuals, organizations and Advisory Committees having responsibility for carrying out the specific implementation plans of this development plan.

10.1 TACTICAL CHANNEL RADIO (Public Safety Emergency Radio System)

1. It is recommended that the State Planning Agency/Iowa Crime Commission make application to the LEAA for funding to develop this Tactical Channel system for all counties:
   a) Which agree to upgrade their operations to meet the requirements of this plan,
   b) To operate 24 hours per day in accordance with the rules and regulations approved by the Commissioner of Public Safety,
   c) Which will agree to install and maintain such equipment.

10.2 POINT-TO-POINT CHANNEL RADIO

1. It is recommended that the usage of the Point-to-Point Channel by the Iowa Highway Patrol Radio centers be continued for broadcasting an alert of severe weather warnings to all county Comm Centers.

2. It is recommended that the Point-to-Point Channel radio system (155.370 MHz) be equipped to operate as a simplex voice grade link to receive data transmissions from another agency and to be manually switchable to either receiving or transmitting to another agency within radio range.

3. It is recommended that the Chief, Communications Division of Iowa and the Chief Radio Engineer engage in inter-state discussion with other states communications personnel who are responsible for planning; and with the FCC and the National APCO in an attempt to convert the 155.370 MHz frequency usage <u>from</u> a single frequency simplex, non-CTCS, non-selective calling, <u>to</u> a voice/data system which has selective calling with nation-wide standards of code assignments and procedural use for base stations only.

10.3 TELEPHONE SERVICES

1. It is recommended that incoming emergency request lines represent wherever possible a single dialing number which is available within all parts of the area being served by the Comm Center. The 911 system is the only known configuration providing this feature.

2. It is recommended that planning in each county include the 911 for county seat cities and especially should include cities having a population of 10,000 or more. Larger metropolitan area 911 services should include an area which now extends to the limits of toll-free service.

3. It is recommended that the emergency request telephone system utilize calling numbers differing from those of the administrative system to assure that the busy conditions of one system do not cause the other to become overloaded.

4. It is recommended that upon establishment of a county Comm Center, there be published on the first page of telephone directories of that county emergency service telephone numbers for calling that center. This emergency call will enter the center via a multiple line rotary.

5. It is recommended that telephone company business and engineering representatives be requested to review specific equipment and service requirements for each Comm Center planning consistent with agency's capabilities and requirements.

10.4 AUTOMATIC COMMAND/CONTROL/INFORMATION SYSTEMS

1. It is recommended that evaluation results of automatic command and control/information system operation now being conducted in other states and their cities, be reviewed periodically by the Division of Communications or representatives, with intent to develop at least one or two active trial usages of the best of these in cooperation with forward looking agencies in the State of Iowa. Proposals for Federal aid should be considered to partially fund these projects.

2. It is recommended that results of mobile data systems evaluation projects which are being conducted in other states and their cities, be reviewed

periodically by the Division of Communications with regards to establishing at least one or two active agency trial usages of the best of each. Proposals for Federal aid should be requested for these projects.

3. It is recommended that regardless of data system usage, a concerted effort be made by each Comm Center Governing Board to coordinate policies for improvement of data files and to develop state-wide/nation-wide formats for data retrieval and transmission to mobile officers.

4. It is recommended that available and mobile data system and automatic vehicle monitoring system evaluation results being conducted by other states and cities be reviewed periodically by the Division of Communications with planned development for establishing at least one or two active agency usages of the best of these. Proposals for Federal aid should be considered in funding these projects.

5. It is recommended that Chief, Communications Division study present requirements for state-wide data communications systems and evaluate them to define requirements which will enable the development of a long range master plan for data and voice communication between and within local, regional and state agencies and which will insure total system compatibility and economy.

10.5 PROCUREMENT

1. It is recommended that the State Communication Advisory Committee be responsible for the state-wide coordination, update and adequacy of technical specifications used for communications equipments and systems and in system purchasing. When required this group should request technical assistance from the General Services Department.

2. It is recommended that the administration of each local (city, county, or region) communication system designate a specific individual(s) within a specific agency to be responsible for all purchasing for that system.

3. It is recommended that the administration for each local (city, county, or region) communication system or an appointed committee thereof take

responsibility for developing written procurement policies and purchasing procedures for that system.

4. It is recommended that each local (city, county, or region) communication system contract for the services of a competent communications consultant if other recognized resources are unavailable to act as system engineer.

5. It is recommended that the State Communications Advisory Committee on request of the Crime Commission provide assistance and guidance in establishing priorities and in approving technical exceptions during the implementation of this plan.

6. It is recommended that the Crime Commission develop a set of applicable guidelines for preparation and for approval of grant requests for implementation of this communication plan. The guidelines will address such items as:

(a) Degree of Compliance:

1. Regional or county inclusion of all law enforcement agencies in Comm Center. Cooperation statements desired,
2. Establishment of Communications Governing Board for agency representation,
3. Tactical subsystem implementation inclusion and agreement to comply with operating rules and regulations,
4. Frequency plan compliance, operations channel,
5. Implementation in accordance with suitable Generic System plan herein defined,
6. Emergency request telephone system installation,
7. Staff upgrade and training,
8. 24 hour operation,
9. Continuous funding for operations (joint).

(b) Need Justification:

1. Increases the degree of improvement in inter-agency coordination,

2. Priority as applied in this plan,
3. Schedule of implementation as applied in this plan,
4. Crime index rating (weigh equal need in favor of implementing the system where crime index is greater),

(C) Development of Matching Fund Sources

1. Local matching funds, cash and In-kind
2. State matching funds, cash and In-kind
3. SPA matching funds.

7. It is recommended that in state-wide budgeting for procurement, that five to ten thousand dollars per year be allowed over estimated costs to equip mobile units with a decode function for installation in those jurisdictions which may find a nuisance interference after installation. This is particularly important for the Operations Channel.

10.6 GENERAL

1. It is recommended that the City of Des Moines be asked to change their usage of UHF frequency 460.325 MHz and 465.325 to 460.350 MHz and 465.350 MHz to correct an intermodulation product in the present frequency usage.

2. It is recommended that when regional planning is completed involving either Grundy, Washington, Decatur, Van Buren, and Crawford Counties that additional site location cost effectiveness and signal reliability analysis be performed based upon the available sites and the selection of Comm Center city locations for the county or region.

3. It is recommended that a project be established jointly by the Division of Communications, the Department of Public Safety, and the Crime Commission to develop a "standard light bar" configuration for use of law enforcement (public safety) vehicles using mobile radios. Requirements should strongly favor minimizing the antenna azimuthal radiation pattern variations. Upon establishment of the standard a series of antenna pattern measurements shall be made to determine the most effective mobile antenna configuration and vehicle mounting specification for the Iowa Telecommunications system vehicles.

4. It is recommended that each county organize a Governing Board of user agencies in order to develop this implementation plan in their jurisdiction.

5. In planning construction of new Comm Center and Base Station facilities there should be cooperative planning with the Civil Defense Director in consideration of the emergency operations long term emergency power aid fallout protection, also mobile Comm Center.

6. It is recommended that there be established a Communications Advisory Committee consisting of from 11 to 13 members appointed by Sheriffs Association, Iowa Chiefs of Police, The Iowa APCO, Department of General Services and Department of Public Safety, to assist the State Planning Agency in the implementation of the plan state-wide when LEAA funds are to be expended, EMS, fire, and other agency members may be named for coordination and mutual planning cognizance.

7. It is recommended that specific rules be established by the Communications Advisory Committee for use of the Wide Area Channel (IHPR "LEA" Channel).

8. It is recommended that the Communications Advisory Committee be responsible for the state-wide coordination of state-wide law enforcement communications planning and to request technical assistance from the General Services Department, Division of Communications.

11.0 REFERENCES

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   Standards:
   (a) 1.4 Communicating with the Public
   (b) 5.1 Responsibility for Police Service
   (c) 8.1 Establishing the Role of the Patrol Officer
   (d) 8.3 Deployment of Patrol Officers
   (e) 9.7 Criminal Investigation
   (f) 23.1 Use of the Telephone System
   (g) 23.2 Command or Control Operation
   (h) 23.3 Radio Communications

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12.0 DEFINITIONS AND EXPLANATION OF TERMS

Agency

A term used to identify a law enforcement organization or group of organizations using the communications system. Usage of the term with a modifier such as sheriff agency or city law enforcement agency refers to the generic sheriff agency or the generic city law enforcement agency.

CTCSS

Continous Tone Code Squelch System Sometimes the final "S" is omitted when referring to the tone itself or the encode or decode function.

Channel

An assigned communications transmission service function. More than one path or link may serve a functional channel requirement.

1) Specifically for this report, the Information Channel functions to provide the transmission of information (data) requests and a link for receiving the information.

2) Tactical Channel - functions to provide the mobile-to-mobile Mutual Aid communications related to inter-agency and intra-agency criminal apprehension activities and for transient officer assistance.

3) Operations Channel - functions to provide the routine communications between mobile units and their Comm Center operational command and control dispatch.

4) Wide-Area Channel - functions to provide specific mobile-to-mobile communications between units of a given agency

Channel (cont'd)	over distances beyond that possible unit-to-unit. Second, it will provide an inter-agency vehicle extended range in sheriff-to-city or to IHP mobile officers.
Comm Center	The facility complex of equipment and personnel from which all communications activity for a specific agency, county, or regional group of agencies is controlled.
Decibel (abbreviated dB)	The logarithm of the ratio of one number to a standard reference number. Usually used for the ratio of electrical power ($10 \log P_2/P_1$) or voltage ($20 \log V_2/V_1$).
Dispatchers	The personnel who are assigned the Comm Center radio operator function and the emergency request/complaint channel response function.
dBi	The decibel power gain of a specified antenna relative to that of a hypothetical spherical pattern antenna radiating or receiving equally in all directions. This isotropic antenna gain has been assigned the value 0 dBi.
dBd	The decibel power gain of a specified antenna relative to the gain of a lossless half-wave dipole antenna in free space. The lossless half-wave dipole has a 2.15 dBi gain.

dBw	The decibel ratio of the power output of a given source (usually a radio transmitter) to a one watt source. 0 dBw defines a one watt output level.
dBm	The decibel ratio of the power output of a given source to a one milliwatt source. 0 dBm defines a one milliwatt level 30 dBm equals 0 dBw.
Generic System	A system model which describes the general characteristics, channels and frequency usage for a number of typical or an aggregate characteristic for several agencies.
Information Channel	See Channel 1 definition.
IHP	Iowa Highway Patrol mobile unit
IHPR	Iowa Highway Patrol Radio. The operational radio Comm Center, a base/repeater station or frequency may be referenced.
LEA	Law Enforcement Agency(s). Reference all agencies in Iowa unless modified such as "city LEA's".
LEATAC	Law Enforcement Administrators Telecommunications Advisory Committee
Link	The transmission - reception equipment and medium forming a two-way path for communications (radios, telephone, teletype, etc.) in a particular channel. A frequency or frequencies are associated with radio links.

MCA	Marginal Coverage Area This term relates to the signal area where signal reliability is less than a specified amount, e.g. 50% service probability index. (SPI)
Maximum Peak Message Rate	The number of messages which are transmitted during the busiest five (5) minute period of a busy hour. In this report, the predicted message traffic values for radio and telephone are the maximum peak message rates. This assures an adequate system channel capacity for the public safety emergency high message traffic periods.
MSL	Mean Sea Level. A topographic reference to the mean level of the earth's seas. Used to reference heights of terrain features or artificial structures (radio towers foundations) above sea level.
Operations Channel	See Channel 3 definition.
S/N_o	Signal strength to noise power ratio usually measured in 1 Hz bandwidth and expressed in decibels.
SPI	Service Probability Index This term describes the statistical reliability and confidence factor associated with the Longley - Rice propagation prediction program for computer analysis.
Tactical Channel	See Channel 2 definition.

TBA	To Be Added.
Wide-Area Channel	See Channel 4 definition.
$>$	The value on the right of symbol is less than that value to left of symbol.
$<$	The value on the right of symbol is greater than the value to left of symbol.

13.0 DETAILED IMPLEMENTATION PLAN

13.1 SIOUX CITY POLICE DEPARTMENT UHF SYSTEM

The UHF system designed for the Sioux City Police Department is based on projected message traffic load and the topographic features requiring special consideration to ensure adequate circuit capacity and area coverage, respectively. Involved in the planning was the requirement to use available city owned property, such as municipal water tower sites, to preclude time-consuming and expensive land condemnation or procurement proceedings.

The initial implementation for the radio communication system will have three (3) UHF transmit/receive frequency pairs which are used for two links of the Operational Channels and the one link Information Channel. The frequencies are assigned as follows for the base station transmit/receive:

460.075 / 465.075	
460.175 / 465.175	
460.300 / 465.300	
460.400 / 465.400	To be used should South Sioux City become a part of the Metropolitan Comm System.

The tone encode / decode frequency to be used is 146.2 Hz.

See Figure 13-1 for a block diagram which depicts the arrangement of the main transmitters and the satellite receiver system. The mobile and portable operation into this system uses the 1-watt hand held portable which provides adequate coverage when operated with the satellite receiver system. Using the same portable unit plugged into the vehicular charger mount, external antenna, auxiliary audio system with speaker, and a separate hand held microphone, the operation from the mobile will be very reliable. Following is a brief description of each equipment location and the function it performs:

<u>Communications Center:</u> (Reference Table 13-1)

The communication center remains in its present location at the Police Department Headquarters. The control console currently installed is modified to provide the necessary remote control functions for the UHF system. A second console with parallel functions shall be installed which would provide two operating positions for the radio dispatchers. Two telephone operator positions are required in addition to the two radio operators at peak busy hours. Radio operators shall have ready access to the emergency incoming telephone lines to assist in busy hour traffic handling during the peak shift. The telephone system must provide eleven (11) incoming emergency lines which may be answered by one of four operator positions. An appropriate number of outgoing lines are required for connection to associated agencies and incoming lines from these agencies (unlisted numbers and dedicated lines may be used). Radio and recorder terminations and cross connections are needed also.

Sioux City is predicted to have a traffic density exceeding the capability for a Call Director instrument. It is possible to use a recessed button (400 series) console, however with the great possibility for 911 emergency calling developing in the greater metropolitan area, it is recommended that usage of the Bell 310 (or equivalent) switching console be considered for the two telephone operator/dispatcher consoles. The specific engineering detail must be developed by telephone company engineering personnel for this and at the radio dispatch consoles.

The communication center is equipped with the satellite receiver comparator terminals as well as a back-up transmitter capable of operating on two of the UHF channel pairs. The antenna system located at the Police Department will not be adequate to provide city-wide reliable signal transmission/reception, but will satisfactory for a disaster type operation, should the main transmitter group be disabled. Receivers for all three frequencies are installed at the Police Department and are included in the satellite receiver complement. The satellite receiver system is also utilized in the repeater system to provide access from any location within Sioux City.

All incoming emergency telephone lines, as well as the audio lines for the radio communication are recorded on multichannel tape recorders. TRACIS information is provided from existing installed equipment. Emergency power is now operational at the Police Department complex.

Main Transmitter Remote Base: (Reference Tables 13-2, 13-6 and 13-7)

The main transmitter site requires a new tower located nearby the water tower at the North Cheyenne and 41st site. Three (3) separate remotely operated transmitters with companion receivers and duplexers will be installed in the enclosed area under the water tower which is available for equipment and has commercial power terminations. A new 200-foot tower is erected, preferably a guyed tower, but a self-supporting may be necessary due to specific site conditions, to support three (3) UHF antennas plus the county -wide high-band antenna when the Tactical/Info system is implemented. See Figures 13-2 and 13-3.

UHF signal transmission reliability from this location provides signals exceeding the specified grade of service to the entire city as well as county-wide for the high-band system. Control and audio lines for the transmitters and receivers are standard voice-grade leased telephone circuits. Emergency power is provided by a 7.5 KW gasoline powered generator set with automatic cut over in the event of utility power failure.

Remote Satellite Receivers: (Reference Tables 13-3 and 13-4)

In addition to the satellite receiver groups located at the Comm Center and at the north water tower remote base site, remote or satellite receivers are also located in the Riverside area site and the Morningside area site. Riverside and Morningside have two (2) receivers each which are crystalled for the Operations Channel links 1 and 2 or optionally, one Operations link and the Information Channel link. Should message traffic load develop in these areas to a level requiring a full complement of links, the third receiver set can be readily added. Access to a repeater channel is provided through the sat-receiver system.

The Riverside site location is not critical, except to assure antenna illumination of the river road without intervening obstacles such as buildings or very close to land prominences. The recommended site should be selected in an area west of Bryan and within a few blocks either side of Goldie Avenue. An antenna support height of 80 to 100 feet above ground level will be adequate for this location.

Emergency power for the receivers and tone panels is provided by battery sources which are kept under trickle-charge during operation from the normal commercial power source. The equipment housing is optionally in a municipally controlled premise (public building, school, etc.) or a weatherproof pole mount type enclosure. The facility should be reasonably free from intrusion. Audio signals from the receivers are transferred to the Comm Center receiver comparator terminals via leased voice-grade telephone circuits .

The receivers at Morningside are configured just as in the Riverside location except for the antenna which can be conveniently mounted on the top of the water tower located at Stone and Maple. Equipment will be either installed in the Water Works enclosure or in a weatherproof pole mounted unit, dependent upon availability.

Mobile Units: (Reference Table 13-5)

The mobile units specified for Sioux City are the removable UHF personal portable units which are inserted in a vehicular charger mount with outside antenna connection, an external speaker with audio amplifier, and a separate hand held microphone. The antenna mounted external to the vehicle is considerably more efficient than the hand held portable antenna and will provide an additional 10 to 15 dB of effective radiated power beyond that experienced with the hand - held portable. This represents additional range reliability when operating with the city and from areas outside the city limits as would be done during operations which take the mobile patrol out into the county.

Mobile-to-mobile communications (others than through the repeater) in the "talk around" mode can be provided on the second operations channel by crystalling both the mobile transmitter and receiver on the base transmit frequency. Provisions for a monitor receiver on that base transmit frequency will be necessary to prevent interference to the mobiles during a priority communication exchange. One receiver located at the north water tower site should suffice to receive over 98 percent of the mobile talk around transmissions and over 90 percent of the portable usage in this mode.

Portable Operation:

As previously described for the mobile operation, the hand held portable radio is extracted from its vehicular charger mount by the mobile officer for an onfoot operation. The fully charged unit provides the using personnel service condition capable of an eight hour shift within the 80,10,10 duty cycle. Provision for key locking the portable unit into the vehicular charger mount is specified to prevent theft from the vehicle. Battery chargers at the Comm Center are required to provide extra charging capacity for spare battery packs and the personal portable units.

13.2 SUPPLEMENTARY INFORMATION FOR WOODBURY COUNTY HIGH-BAND SYSTEM

The Woodbury County high-band transmitting system is shown in Figures 13-2 and 13-3. It is not known at the time of writting if the county will utilize the low or high-band Operations Channel. Tables 13-6 and 13-7 are indication of equipment required when either option is chosen. Folowing are precautionary comments for implementation.

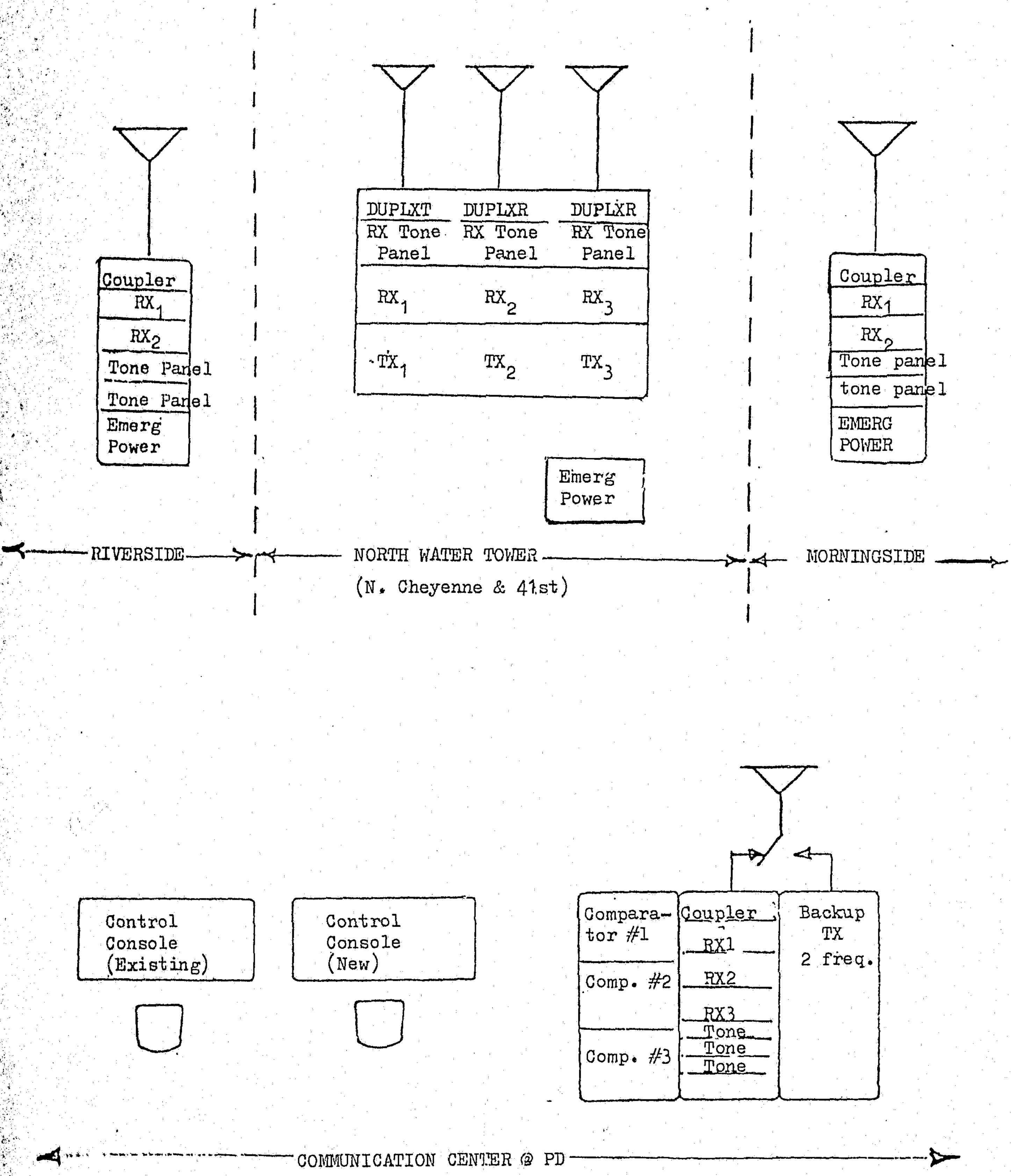
The close proximity of the Sioux City fire department high-band communication system antenna on the water tank adjacent to the proposed HB/UHF transmitting tower can potentially be troublesome through transmitter noise sidebands causing receiver desensitization of either the law enforcement or fire department. Also, transmitter inter-modulation products are potential sources of nuisance interference and desensitization.

The desensitization of the fire department's receivers (154.250 and 154.280 MHz) can be eliminated by adding a 2-cavity symmetrical notch filter at each of the county-wide high-band transmitter output terminals to provide attenuation of the wide-band noise at the fire department's operating frequencies. This will introduce an additional insertion loss of 0.3 to 0.5 dB which will reduce the power available to the antenna by 10%. It is recommended that the system be tried first without the additional filtering adding the filtering only if necessary, as it is an item which can be readily installed without affecting the rest of the system.

Similarly, the fire department high-band transmitter can affect the county-wide high-band law enforcement. Notch filtering will be necessary in the fire department's transmitter transmission line to reduce the level of its wide-band noise to prevent desensitization of the Tactical, Information, and Point-to-Point receivers. Here again, the symmetrical notch filters (one 2 cavity filter centered on 155.070 MHz and another 2 cavity filter centered on 155.420 MHz) should not be added until the system is checked out and the need for the filters is demonstrated.

Intermodulation products for the various combinations of frequencies present at the north water tank show that a portable unit operating within a half mile radi.. of the transmitting site and transmitting on 155.850 MHz while the base transmitter is operating on 155.070 MHz could generate an inter-modulation product of 154.290 MHz, within 10 KHz of the fire mutual aid frequency. The probability for this is not very high (a few times a day perhaps) and hence, is not considered significant in reducing the channel reliability.

FIGURE 13-1 SIOUX CITY POLICE



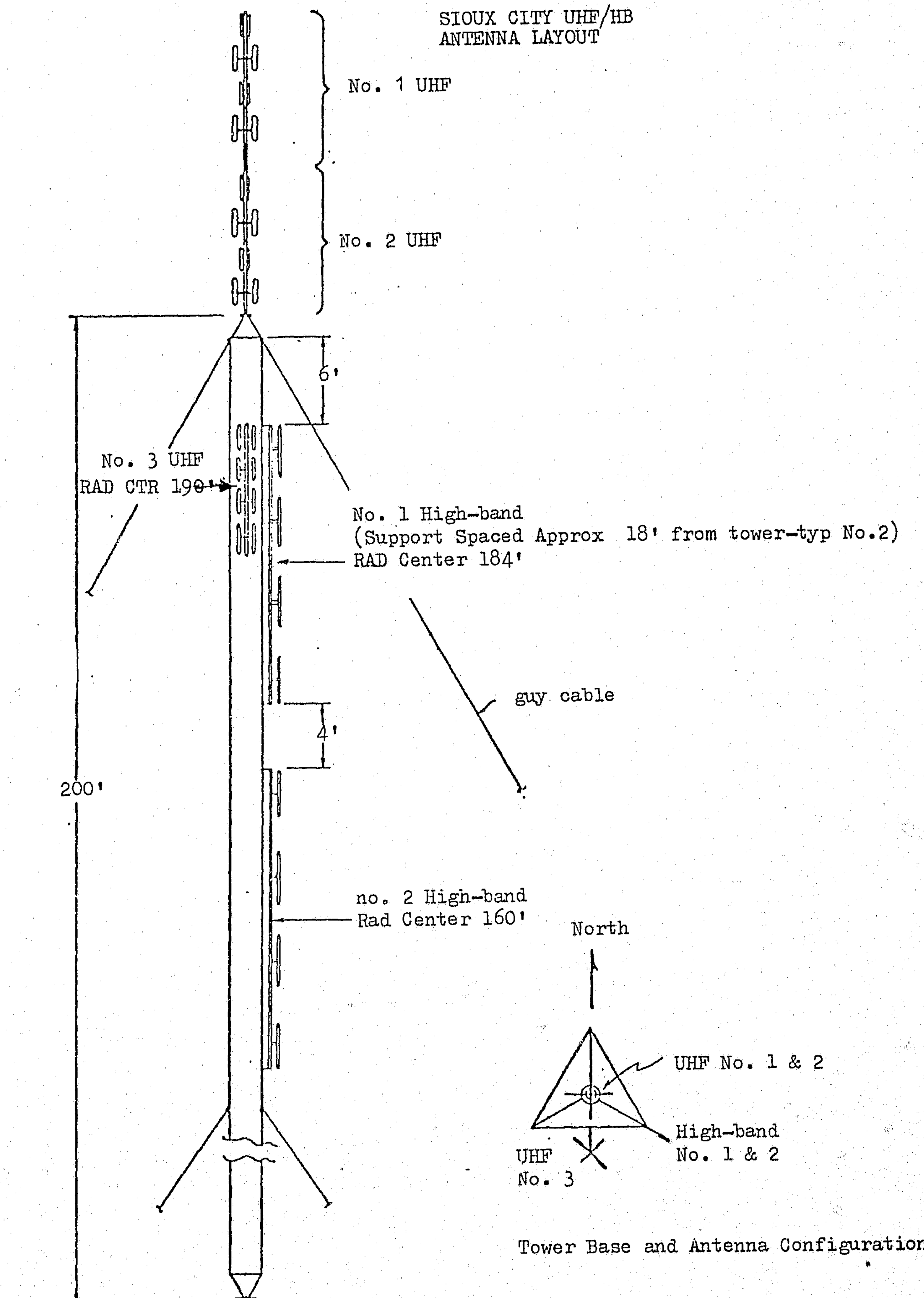

SIOUX CITY UHF/HB
ANTENNA LAYOUT
No. 1 UHF
No. 2 UHF
6'
No. 3 UHF
RAD CTR 190'
No. 1 High-band
(Support Spaced Approx 18' from tower-typ No.2)
RAD Center 184'
guy cable
4'
200'
no. 2 High-band
Rad Center 160'
North
UHF No. 1 & 2
High-band
No. 1 & 2
UHF
No. 3
Tower Base and Antenna Configuration

FIGURE 13-2

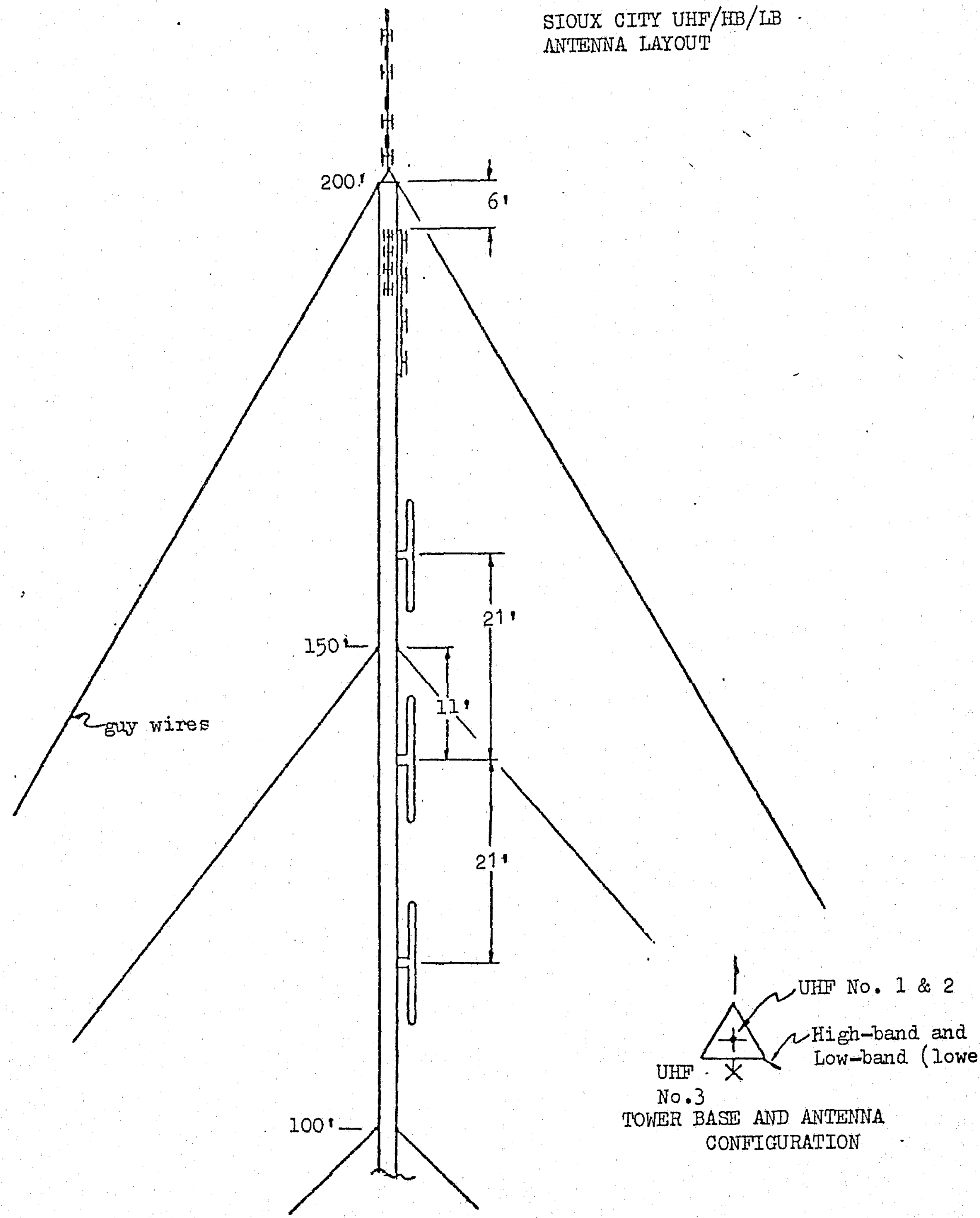

SIOUX CITY UHF/HB/LB
ANTENNA LAYOUT
200'
6'
21'
150'
11'
guy wires
21'
UHF No. 1 & 2
High-band and
Low-band (lowe
UHF
No.3
TOWER BASE AND ANTENNA
CONFIGURATION
100'

FIGURE 13-3

Table 13-1

Communications Center:

Qty	Item Description	Spec No.	Cost Each	Extended Cost
1	Control Console (new)	U	7000	7000
1	Modifications for existing console	U	2000	2000
1	Backup transmitter, UHF, 2 - frequency	A-2 - 25	3000	3000
3	UHF Rx for Ops 1,2 & Info.	B-1	630	1890
1	Rx antenna coupler	V-1	385	385
3	Tone encode panels for satellite Rx	S	200	600
1	2-Rx Comparator for satellite Rx	S	1500	1500
2	4-Rx Comparator for satellite Rx	S	2000	2000
1	Antenna 4-stack collinear array, 6.0 dBd	D-2	160	160
1	Antenna Tower (On PD roof, 50' or equivalent)	T	600	600
1	100' heliax, 7/8 foam	L	220	220
				$ 21,355
	Installation and contingency (20%)			4,271
				25,626
add				
1	Multi-channel tape recorder	O		12,000
	With remote control			2,000
				$ 39,626

Table 13-2

Remote Base at N. Water Tower (Cheyenne and 41st.)

Qty	Item Description	Spec No.	Cost Each	Extended Cost
3	Transmitters, UHF, 90 watt	A-[illegible] - 100	3000	9000
3	UHF Rx, for Ops 1,2 & Info.	B-1	630	1890
3	Tone encode panels for Sat Rx	P/O S	200	
3	Tx/Rx Duplexers	C	345	1035
1	Antenna, 4-stack collinear	D-2	160	160
1	Antenna, dual, collinear	D-3	280	280
1	Antenna Tower 200' (self-supporting if necessary)	T	*	*
3	250 ft lengths heliax, 7/8 air	L	606	1818
1	Emergency Power Unit	R	2500	2500
			Less Tower	$ 17,283
	Installation and Contingency		(20%)	3,465
				$ 20,748
	*with 200' tower installed			14,775
				$ 35,523

* Add one monitor Rx if "talk around" is implemented. ($630.00)

Table 13-3

Riverside

Qty	Item Description	Spec No.	Cost Each	Extended Cost
2	UHF Rx for Ops 1&2	B -1	630	1260
2	Sat. Rx tone encode panels	P/O S	200	400
1	Receiver antenna coupler	V-2	385	385
1	150''Heliax, 7/8 foam	L	370	370
1	Emergency battery backup power	P/O S	200	200
1	Antenna, 4-stack, collinear	D-2	160	160
1	Antenna support, 80-100ft.			600
				$ 3,375
	Installation and Contengincy (20%)			675
				$ 4,050

Table 13-4

Morningside Water Tower (Stone and Maple)

Qty	Item Description	Spec No.	Cost Each	Extended Cost
2	UHF Rx for Ops 1 & 2	B - 1	630	1260
2	Sat Rx tone encode panel	P/O S	200	400
1	Receiver antenna coupler	V-2	385	385
1	150 ft. heliax, 7/8 foam	L	370	370
1	Emergency battery backup power	P/O S	200	200
1	Antenna, 4-stack, collinear	D - 2	160	160
				$ 2,775
	Installation and Contingency			555
				$ 3,330

Table 13-5

Mobile Units

Qty	Item Description	Spec No.	Cost Each	Extended Cost
40	Personal Portable (1W) 4 Frequency	P - 2	1265	50,600
40	Mobile charger/console for operation from external antenna hand-held mike, and auxiliary audio w/speaker	P/O P-2	200	8,000
1	Battery Charger (12 Unit)	Y	650	650
12	Extra ni-cad batteries		50	600
				$ 59,850
	(20%) Installation and Contingency			11,970
				$ 71,820

Total Cost Sioux City PD $ 154,349.00
(No TIP radios)

Mobiles

Qty	Item Description	Spec No.	Cost Each	Extended Cost
40	TIP radio for Sioux City Police Dept.	M	1300	52,000
14	Woodbury Co. Sheriff	M	1300	18,200
				$ 72,200
			Installations and Contingency (20%)	14,040
				$ 84,240

Table 13-6

EQUIPMENT LIST AND BUDGETARY COST FOR COUNTY-WIDE HIGH- BAND

HB Tactical/Info System (Assumes Sheriff Dept. Operations on LB)

Qty	Item Description	Spec No.	Cost Each	Extended Cost
1	HB transmitter, 100W, 4-freq.	E-2	3500	3500
1	Rx Single frequency	F	480	1440
2	Rx Single Frequency	F-1		
1	Rx, coupler, 4-port	G	450	450
1	Antenna	D-5a	185	185
1	Tower, 200' (typical)	T	33/ft.	6600
225 ft.	7/8 foam heliax w/connectors	LL	1.80 ft + 40	445
-	Remote controls for 2 consoles	U as req'd	1000	2000
				$ 14,610
			Installation and Contingency (+20%)	2,922
				$ 17,532

Table 13-7

OPTION FOR ADDITION OF HIGH-BAND OPERATIONS CHANNEL - COUNTY -WIDE SYSTEM

Qty	Item Description	Spec No.	Cost each	Extended Cost
1	HB transmitter, 100 w, 1 freq.	E - 1	2,500	2,500
1	HB Receiver, 1 freq.	F - 1	480	480
1	Tac/Info filter (No. 3)	J	300	300
1	Operations Channel filter (No.1)	H	300	300
1	Operations Channel filter (No.2)	I	210	210
1	Antenna	D - 5a	185	185
200 ft.	Transmission line, 7/8 heliax	L	400	400
1 set	Remote controls for Comm Center	U	1,000	1,000
				$ 5,375
			Installation and Contingency (+20%)	$ 1,075
				$ 6,440

Option For Addition of High-Band Personal Portables For Sheriff Department.

Qty.	Item Description	Spec. No.	Cost Each	Extended Cost
6	VHF Portable, 5-watt (Nominal), 4-frequency	Q	$ 1150	6,900

Grand Total - Sioux City PD and Woodbury County $ 269,561.00

13.3 BURLINGTON POLICE DEPARTMENT UHF SYSTEM

The UHF system required for the Burlington Police Department is a single-duplex channel, remotely controlled, transmitter/receiver plus one extra remote receiver located in an existing poor coverage area. The existing transmitting/receiving site located at 1706 Dehn Street was to be retained along with the 150 foot self-supporting tower. The change to UHF is partly necessary to overcome a high ambient noise problem (attributed to arcing insulators in the utility power distribution system) and to obtain coverages into a dead zone which exists along the road at the base of the river road running north of the business district.

Figure 13-4 is a block diagram for the UHF communication system. The transmitter/receiver group installed in the shelter at 1706 Dehn Street has the capability for repeater operation and normal remote base operation by the dispatcher. Tone encode is used on the mobile and portable transmit for reception at the remote base station receiver which has a CTCSS decoder. A second receiver is installed at the edge of the bluff overlooking the river road to overcome the inability of the mobiles and portables to satisfactorily talk out of the riv road area.

Both Operations and Information (TRACIS) communications will be adequately covered by the duplex channel. Upon implementation of the county-wide high-band Tactical/Information System, a back-up system is available to cover overloads due to disaster or emergency situations. See the follow-on section which describes the Des Moines County communication system up-grade.

A budgetary cost estimate is shown in Table 13-8 which details the major componen and effort required to implement the Burlington UHF system. Costs used are typically catalog or list prices prevalent in 1973. Specification No. reference relates to the equipment specifications to be found in the Appendix to the Iowa Telecommunications Plan, Volume I.

13.4 DES MOINES COUNTY LAW ENFORCEMENT COMMUNICATIONS SYSTEM

The Des Moines County law enforcement communication system has a planned upgrade along with all the other counties in the state. It is cost effective to plan that the Des Moines County Sheriff's Department radio communications be integrated with the Burlington communications and a joint Communications Center be established. This arrangement would provide a professional, twenty-four hour per day, seven day per week, control center for emergency telephone requests for assistance and dispatch of appropriate emergency vehicle or service. See Figure 2-6, Vol I, for a generic system diagram.

Briefly, the Des Moines County high-band Tactical/Information/Point-to-Point (TIP) system consists of the generic system described in Iowa Telecommunication Plan, Volume I, Table 2-1, Table 2-2, and Table 2-4. The remote site remains at the county home and the water tower provides the support for the antenna which is mounted on the top of the tower. Control/audio lines for the remote transmitter and receivers are leased from the telephone company as currently done.

The Operations Channel can remain on low-band after recrystalling the base station equipment and mobile units to correspond to the revised frequency plan. The antenna recommended for low-band is normally a two folded dipole, omni array which needs to be sidemounted from a standard steel tower. However, the continued use of the water tower is possible by using a coaxial half-wave dipole which is supported by an auxillary pipe mast attached to the water tower catwalk (not the ladder) and with sufficient height for the bottom of the antenna to clear the water tank top by 15 to 20 feet. Should it be deemed desirable to abandon the water tower for antenna support, a steel tower should be erected to provide the radiation centers for the antenna as specified in Table 2-4 (Vol I). The Table 13-9 which follows is a budgetary estimate for the county-wide high-band Tactical/Information/Point-to-Point system, upgrade of low-band Operations channel, and provide enough Tactical mobiles for the county and municipal LEA units.

Personal Portable

	Tx	Rx	Tone Encode
Chan 1	465.075	460.075	yes
Chan 2	460.075	460.075	no
Chan 3	Surveillance		no
Chan 4	TBA	TBA	

Mobile Channels - UHF

	Tx	Rx	Tone Encode
Chan 1	465.075	460.075	yes
Chan 2	460.075	460.075	no
Chan 3	Future data use		yes
Chan 4	TBA	TBA	

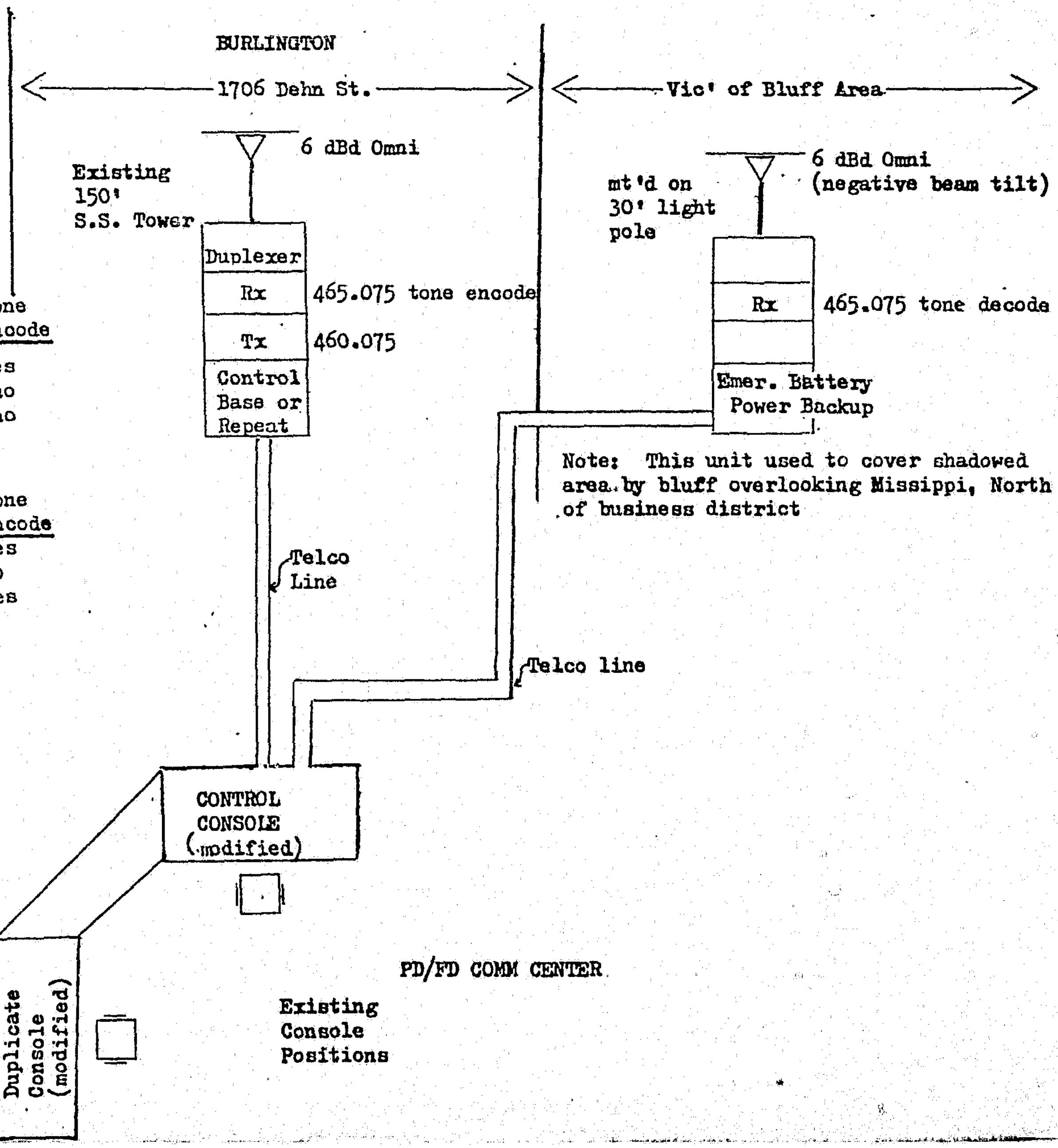


TABLE 13-8

BURLINGTON POLICE DEPARTMENT

Communication Center:

Qty	Item Description	Spec No.	Estimated Cost Each	Extended Cost
1 group	Modify existing consoles to add UHF control functions	-	2,000	2,000
		Subtotal		$2,000.00

1st Remote Base/Repeater (1706 Dehn St.):

Qty	Item Description	Spec No.	Estimated Cost Each	Extended Cost
1	UHF Transmitter, Single freq. 60 W	A	3,000	3,000
1	UHF Receiver, Single freq, CTCSS Decode	B-1	630	630
1	Duplexer	C	345	345
1	Antenna, 4-stack collinear array, 6.0 dBd	D-2	160	160
160'	7/8 in., heliax, (air) and connector kit	L	2.20/ft	352
		Subtotal		$ 4,487.00

2nd Remote: Receiver (Vic' of Bluff area - North of business district)

Qty	Item Description	Spec No.	Estimated Cost Each	Extended Cost
1	UHF Receiver, single freq. CTCS decode	B-1	630	630
1	Emergency Battery Power Supply	-	200	200
1	Antenna, 4-stack collinear array, .0 dBd	D-1	160	160
1	Antenna Support, Pole (30') Light standard	N/A	-	-
30	$\frac{1}{2}$ in. heliax, (Foam)	L	.70/ft.	43
1	Outdoor pole mount cabinet for Rx	AA	150	150
40'	Security Fence (10'high, chain link)		10/ft	400
			Subtotal	$ 1,583.00

Mobile Units:

Qty	Item Description	Spec No.	Estimated Cost Each	Extended Cost
10	UHF Mobile, 25W , four freq (2 implemented), tone encode.	N	1250	$12,500.00

Portable Units:

Qty	Item Description	Spec. No.	Estimated Cost Each	Extended Cost
6	UHF Portable 1.1 W, four frequencies	P-1	1200	$ 7,200.00

Subtotal	$ 27,770.00
Installation & Contingency (+20%)	5,554.00
TOTAL COST	$ 33,324.00

TABLE 13-9

DES MOINES COUNTY BUDGETARY COST ESTIMATE

Operations Low-Band System:

Qty	Item Description	Spec No.	Estimated Cost Each	Extended Cost
1	Recrystal base transmitter	--	$100	$100
1	Recrystal base receiver	--	100	100
4*	Recrystal mobile units	--	100	400
1	Antenna mast extension	D-9	194	194
150	½" foam dielectric coax	L	.70/ft.+22	127
	+20% for misc. hardware & installation			164
	*Excludes sheriff's auxilary group			$985

High-Band Tactical/Information System

Qty	Item Description	Spec.No.	Cost Each	Extended Cost
1	HB Transmitter, 100W 4-Freq.	E-2	$3,500	$3,500
2	HB Receiver, single freq.	F-1	480	960
3	HB Receiver, single freq.	F	400	1,200
1	Coupler, receiver	G	450	450
1	Antenna	D-4	185	185
150	7/8" foam coaxial cable	L	$ 1.80/ft.+40	310
	Remote control for 2 consoles.	U	1000	2,000
				$8,605
	+20% for misc. hardware & installation			1,721
				$10,326

TABLE 13-9 Pg. 2

High-Band Tactical/Information Mobiles

Qty	Item Description	Spec. No.	Cost Each	Extended Cost
4	County Sheriff Department	M	$1,400	$5,600
12	Burlington & West Burlington PD	M	1,400	16,800
				$22,400

High-Band Personnel Portable Units

Qty	Item Description	Spec. No.	Cost Each	Extended Cost
9	County Sheriff & West Burlington	Q	$1,400	$12,600

The construction of a county-wide law enforcement radio network is a worthwhile project and this opinion is not meant to discourage such plans, but to utilize Section 29C.7 as a basis for the network totally ignores the intent of the Iowa Civil Defense Act, Chapter 29C. The specifications and requirements of Chapter 28E are easily satisfied and this chapter provides an excellent management foundation for endeavors like county-wide radio networks.

Very truly yours,

J. S. Kelly, Jr.

JOSEPH S. KELLY, JR.
Assistant Attorney General

JSK:jlh

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DIV. OF COMMUNICATIONS
DEPT. OF GENERAL SERVICES
STATE OF IOWA

Department of Justice

CHARD C. TURNER
ATTORNEY GENERAL
OSEPH S. KELLY, JR.
STANT ATTORNEY GENERAL

ADDRESS REPLY TO:
TORT CLAIMS DIVISION
1223 E. COURT, ROOM 201
EXECUTIVE HILLS, EAST
DES MOINES, IOWA 50319
PHONE 281-5881

November 25, 1974

Glen D. Anderson, Jr.
Chief of Communications
Department of General Services

Dear Mr. Anderson:

This opinion is in reference to your request dated August 28, 1974, regarding the Statewide Law Enforcement Radio Plan. You specifically asked whether an integrated communcations dispatch center for a county and participating municipal corporations should be established under the provisions of Chapters 28E or 29C and if these two chapters are interchangeable.

The authority for the formation of a county-wide law enforcement broadcasting system can be found in Chapter 750 of the Code of Iowa (1973). This Office has held in the past that multi-municipality and county agreements of this nature are lawful, see O.A.G., § 7.10 (1965).

In response to your specific question concerning Chapters 28E and 29C, it is this Office's opinion that the two chapters are not interchangeable. Chapter 29C contains Iowa's Civil Defense Act while Chapter 28E is soley concerned with the joint exercise of governmental powers. We grant that Section 29C.7 does provide for cooperation among various governmental bodies, but this cooperation is limited by the express powers and duties designated in Chapter 29C. Chapter 29C authorizes the maintenance of communication systems, however the systems envisioned in Chapter 29C are designed for emergency situations created by natural or manmade disasters. The local cooperation encouraged in Section 29C.7 is not a catch-all for any program that a municipality or county may decide to undertake.

END

4 OF 4