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The Design and Costing of 911 Systems --

A Technical Manual

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The Design and Costing of 911 Systems -- A Technical Manual

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ABSTRACT

This technical manual, which is a result of a two-year study begun in 1978 by SRI International for the Law Enforcement Assistance Administration (LEAA), is designed to assist federal, state, and local officials in planning and implementing cost-effective Universal Emergency Telephone Number (911) service. This manual provides comprehensive step-by-step instructions for designing a 911 system, including 911 system alternatives, personnel and equipment requirements, system implementation procedures, and cost estimate guidelines.

The Bureau of Justice Statistics (BJS) assumed 911 responsibilities from the LEAA with the enactment of the Justice System Improvement Act (JSIA) of 1979.

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CHAPTER I. INTRODUCTION

This technical manual is one of the results of a two-year study for the Law Enforcement Assistance Administration (LEAA) begun in 1978. The overall purpose of the study was to assist federal, state, and local officials in the planning and implementation of cost-effective Universal Emergency Telephone Number (911) service. This work was conducted under contract J-LEAA-010-8, awarded to SRI International by the Systems Development Division of the LEAA. The Bureau of Justice Statistics (BJS) assumed 911 responsibilities from the LEAA with the enactment of the Justice System Improvement Act (JSIA) of 1979.

A. Purpose of This Manual

This manual provides a comprehensive set of step-by-step instructions for designing 911 systems and obtaining estimates of their costs. This document does not cover every possible variation or unusual situation that might be encountered in establishing a 911 system at the local level. It does, however, address the great majority of the circumstances that may be encountered by local 911 planners.

In developing alternative 911 system plans, the following four characteristics must be addressed by the planner:

- Technical characteristics--including system equipment and facilities that will be used in the communications systems.
- Operational characteristics--which describe the way incoming 911 calls are processed, dispatch functions are performed, and information systems are utilized.
- Managerial characteristics--describing the management form and the agreements that control the technical, operational, and fiscal characteristics of the system.
- Fiscal characteristics--which concern the financial plan that is adopted to plan, implement, and operate the system.

This technical manual has been developed to assist local planners in their definition and specification of the first two characteristics listed above--technical and operational--and in the estimation of system costs. An overview of the last two characteristics listed above are covered in this manual. Local planners should use additional sources for guidance in 911 management and finance because of the importance of these components in a total system design. As a matter of fact, in some communities the managerial and fiscal aspects of 911 planning are much more complex and difficult to resolve than are the technical and operational aspects.

B. Organization of This Manual

This manual has been organized to separate and clearly identify the design activities, the costing activities, and the necessary supporting material required in 911 planning.

In Chapter II the step-by-step procedure for designing a system to provide basic 911 service is presented. The design process is divided into seven major parts, each of which is comprised of several steps. All of the technical and operational components of a basic 911 system are described, and detailed examples showing how to compute the required numbers of telephone lines and personnel are given.

In Chapter III the procedure for designing a selectively routed 911 service system is presented. This chapter is organized in the same way as Chapter II, but since most of the design activities are the same for both basic and selectively routed 911 service, Chapter III includes only unique selective routing design activities and those technical and operational components that are specific to a selectively routed system. Reference to the appropriate section of Chapter II is made when a design activity for selective routing is the same as for a basic 911 system.

In Chapter IV the procedures for obtaining a cost estimate (initial and recurring costs) for a 911 system are presented. The costing of both basic and selectively routed 911 systems is covered.

In Chapter V several important non-technical 911 system-design areas are addressed. System management alternatives, system finance alternatives, and a process for performing a cost-effectiveness analysis of alternative systems are discussed in some detail. Also, companion documents to this manual that address public education and staff training are described briefly.

Appendix A contains three tables of data for use in the procedure for computing the required size of the 911 call answering staff. The content and use of these tables are discussed fully in the section of the manual where they appear.

Appendix B contains seven tables that provide the system planner with convenient worksheets listing the principal 911 system elements. These worksheets, when completed, provide the basis for detailed discussions with the telephone company and with equipment vendors. They also will assist planners in obtaining and keeping track of the estimated costs of the various elements of the system.

The glossary of terms at the back of this manual not only defines the principal terms and acronyms that are used in this manual, but also contains a number of other terms that a local planner may encounter during the process of designing 911 service alternatives.

The bibliography on the last page of this manual lists the titles of all of the final report documents and other material that have been developed by SRI during the two-year study in which this manual was developed.

Throughout this manual there are many cross-references to other sections. To assist the reader in rapidly determining the page numbers of those sections that are referred to, the Table of Contents at the front of the manual has been made as detailed as possible. For example, a reference to Section II-D-1-a refers to the subsection of Chapter II listed in the Table of Contents as "Called Party Hold", and which begins on page 21 of the manual.

CHAPTER II. DESIGNING A BASIC 911 SERVICE SYSTEM

A. General Information

A step-by-step procedure for designing a basic 911 service system is presented in this chapter. This procedure is described so that a 911 system can be designed for a complex situation where there are many local public safety agencies, political jurisdictions, and telephone company central office service areas involved. In a less complex situation involving very few political jurisdictions or public safety agencies, some of the design steps may not be required. This is especially true when defining the system boundary and choosing the location for answering the 911 calls.

A number of states have passed legislation concerning 911 service. Most of these states also have a set of mandatory technical and operational standards that must be followed. Therefore, before starting the actual design process, a copy of any applicable state-mandated 911 system standards must be obtained.

If more than one telephone company will be involved in providing 911 service to an area, determine at the beginning of the design process whether one telephone company will act as the main point of contact for all of them, or whether each telephone company will have to be dealt with individually. Normally, the telephone company in whose territory the 911 call answering center will be located (if known in advance) acts as liaison with the other companies involved. There should be no problem if more than one telephone company is involved since the telephone industry has the technical means to route 911 calls to an answering center from two or more telephone companies' areas if necessary.

The 911 system-design process sometimes can be fairly complex, with many interrelated factors involved. In this manual, the design process has been divided into seven areas, each of which, for the most part, can be looked at individually. These areas, listed in the order in which they are addressed, are: (1) System Boundaries and Configuration, (2) System Operation, (3) Optional Telephone Service Features, (4) Telephone Lines, (5) Call Answering and Transfer Equipment, (6) Personnel, and (7) Other Equipment Considerations. The remainder of this chapter addresses each of these seven areas in sufficient detail to enable the development of alternative system designs for basic 911 service.

To assist the planner in keeping track of the various elements that are being designed into the system, seven worksheets are provided in Appendix B. At the appropriate points in this chapter, the planner will be referred to the proper table in Appendix B, in which a notation should be made. A separate set of these worksheets should be used for each alternative system that is investigated.

A summary of the inputs and outputs of the 911 system-design process are shown in Figure 1.

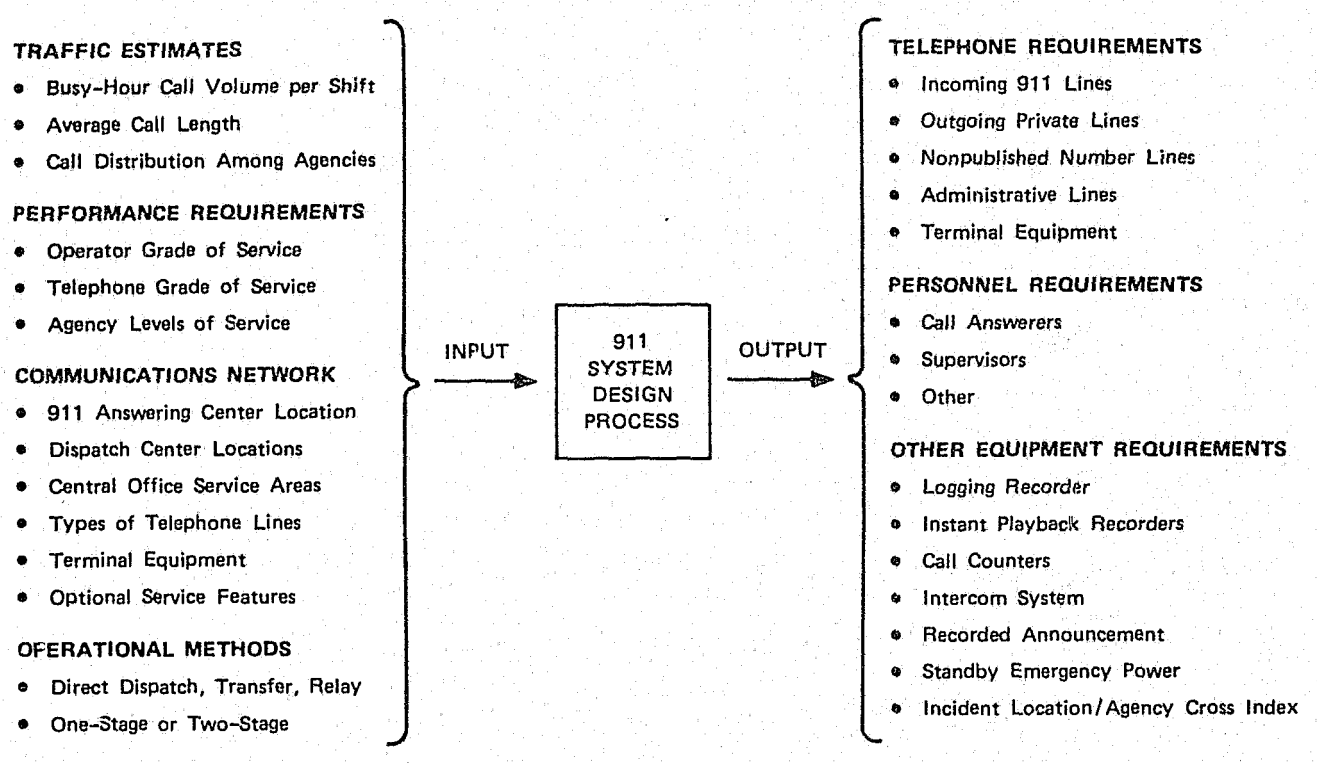


FIGURE 1 SUMMARY OF 911 SYSTEM DESIGN INPUT AND OUTPUT ELEMENTS

The remainder of this section is comprised of a list of action items that together provide a summary of the basic 911 service system-design process discussed in this manual. This list, which can serve somewhat as a checklist, is intended to aid local planners so that no major steps in the design process are overlooked. All of these items will not have to be part of all 911 system designs. Rather, they represent the maximum number of basic steps required in a complex situation.

The items are presented in the same order in which they are discussed. The section of the manual in which each item is discussed is noted in parentheses following each item. When a section is referenced, check the manual's Table of Contents for the page number on which the referenced section begins.

Below is the list of items:

System Boundaries and Configuration

1. Obtain copies of maps showing the service area boundaries and dispatch center locations of the local public safety agencies. (II-B)
2. Obtain estimates of the population served by each local law enforcement agency. (II-B)
3. Copy agency boundaries and dispatch center locations onto a common map. (II-B)
4. Obtain telephone company Exchange Area Boundary Maps. (II-B)
5. Copy telephone central office (CO) service area boundaries onto the map that has the agency boundaries. (II-B)
6. Decide which CO areas will be a part of the 911 system. (II-B)
7. Make a list of all emergency service agencies--local, state and federal--whose emergency calls might be answered by the Public Safety Answering Point (PSAP). (II-B)
8. Develop a table of information listing: (1) the emergency service agencies that are served by each CO, and (2) the name of the dispatch center serving each agency. (II-B)
9. Add local law enforcement area-population estimates to the table. (II-B)
10. Select the PSAP using the common map and the table. (II-B)
11. Develop a table of information that lists: (1) the emergency service agencies that will be served by the PSAP, and (2) the name of the dispatch center serving each agency. (II-B)

System Operation

12. Select a method that will be used to route 911 calls, or the appropriate information, from the PSAP to each emergency service agency. (II-C)

Optional Telephone Service Features

13. Select the optional features to be implemented. (II-D)
14. Decide whether control of any of the optional features is to be passed on to a particular dispatch center. (II-D)

Telephone Lines

15. Decide whether the incoming 911 lines will be direct trunked or tandem trunked. (II-E-1-a)
16. Decide which dispatch centers or other locations will be connected to the PSAP by private tie line. (II-E-1-b)

17. Decide for what purposes nonpublished seven-digit-number lines will be used. (II-E-1-c)

18. Select a grade of service to be used in computing the number of telephone lines required. (II-E-2-a)

19. Select a ringdown time to be used in computing the number of telephone lines required. (II-E-2-b)

20. Determine the average call lengths of emergency calls made to law enforcement, fire protection, and emergency medical service agencies. (II-E-2-c)

21. Select an amount of time, for design purposes, for the call transfer process. (II-E-2-c)

22. Determine the average busiest-hour call volume for each dispatch center and for each other involved agency. (II-E-2-d)

23. Determine the overall 911 system average busiest-hour call volume. (II-E-2-d)

24. Estimate how many of the system's busiest-hour calls will originate from each telephone CO area, and add this information to the two tables which were developed. (II-E-2-d)

25. Compute the number of incoming 911 lines required. (II-E-3)

26. Compute the number of private tie lines required. (II-E-3)

27. Compute the number of nonpublished seven-digit-number lines required. (II-E-3)

28. Decide whether the PSAP's administrative phone number will be an existing published number or a new number. (II-E-3)

Call Answering and Transfer Equipment

29. Summarize terminal equipment requirements. (II-F-2)

30. Select the type of terminal equipment to be used. (II-F-2)

31. Determine the number of pieces of terminal equipment required. (II-F-3)

Personnel

32. Decide if a supervisory position, in addition to the regular 911 call answering positions, is to be implemented. (II-G-1)

33. Determine how many persons will be needed to staff the supervisory position if it is decided to have one. (II-G-1)

34. Decide if the PSAP director will be an employee of a local agency or someone hired specifically for the job. (II-G-1)

35. Decide if the services of a secretary or a data clerk are required. (II-G-1)

36. Select a ringdown time to be used in computing the number of call answerers. Use the same ringdown time that was used to compute the number of telephone lines. (II-G-2-a)

37. Determine the average call answerer occupied time per call. (II-G-2-b)

38. Determine the busiest-hour call volumes for each dispatch center and each other involved agency for the other two PSAP shifts. (II-G-2-c)

39. Determine the overall 911 system busy-hour call volumes for the other two shifts. (II-G-2-c)

40. Add the other two shifts' busy-hour call volume information to Table 2. (II-G-2-c)

41. Compute the number of call answerers that are required to staff each shift. (II-G-3-a or b)

42. Compute the total number of call answerers required. (II-G-3-c)

Other Equipment Considerations

43. Decide which method the PSAP will use to document the 911 calls it receives. (II-H-1)

44. If it is decided to use the audio tape recording method to document 911 calls, determine: (1) which recording procedure will be used, (2) how many tape recorders of what size will be needed, (3) if the proper playback equipment is available or if it must be purchased, and (4) the quantity of audio recording tape that will be needed. (II-H-1)

45. Decide if individual answering position audio recorders are to be implemented. (II-H-2)

46. Determine how many individual answering position audio recorders will be required. (II-H-2)

47. Decide if telephone call counters are to be used. (II-H-3)

48. Determine how many telephone call counters will be required. (II-H-3)

49. Decide if an intercom system is to be used. (II-H-4)

50. Decide if recorded announcement equipment is to be used. (II-H-5)

51. Decide if an emergency power source is to be used. (II-H-6)

52. Decide if an uninterruptable power source is required. (II-H-6)

53. Decide if some sort of incident location/agency cross index must be developed. (II-H-7)

B. System Boundaries and Configuration

The usual starting point for designing a 911 system is the desire of an entire county, several adjacent incorporated municipalities, or a single municipality to investigate 911 service. The first major step is to choose a call answering location and define a system boundary. This step is accomplished by: (1) obtaining certain telephone company and public safety agency service area boundary maps, (2) copying these boundaries onto a common map, (3) obtaining an estimate of the population served by each local law enforcement agency, and (4) analyzing the extent of the boundary mismatches that exist.

The first step in defining the system boundary is to obtain a copy of the service area boundary map from each of the public safety agencies in the area for which the 911 system is to be designed. These agencies must include all local law enforcement, fire protection and emergency medical service agencies, even if one or more of these agencies has not expressed an interest in 911. When requesting these maps, ask each agency to mark on its map the location and name of the facility from which its mobile units are dispatched. If an agency's units are dispatched from a location not within its service area, ask for that location to be described in terms of its geographical location and facility name. Also ask each local law enforcement agency for an estimate of the population that it serves. If the area for which the 911 system is being designed is undergoing a rapid population change, the population figures requested should be the estimated population two or three years from when system planning begins.

The next step is to copy these agency boundaries and radio dispatch center locations onto a common map. An excellent map to use, if available, is a general highway map of the county. Most state departments of transportation have this type of map. If possible, the map should show Bureau of Land Management section lines. These section lines will make it easier to copy the telephone company boundary maps (discussed below) onto the common map. If the service area of any involved public safety agency crosses the county line, then obtain a copy of the adjacent county's map and continue to copy the pertinent boundaries.

At least one state has a mandatory 911 standard which requires that maps submitted with the legally required tentative and final 911 service plans be drawn on the general highway map for the service area in question.

When copying agency boundaries onto the common map, be sure to consider any proposed boundary changes resulting from annexations, mergers, etc., that might take place by the time the 911 system is installed and ready to operate.

Next, ask the telephone company for a copy of the Exchange Area Boundary Map for each of its central office (CO) service areas which are providing service to any public safety agency jurisdictions for which the 911 system is being designed. Obtain a copy of the map even if only a small part of one agency's territory is involved. There should be no difficulty in obtaining copies of these maps since each telephone company is required to file a copy with the state telephone utility regulatory agency. An example of an Exchange Area Boundary Map is shown in Figure 2.

If an Exchange Area Boundary Map indicates that the exchange is comprised of more than one CO, ask the telephone company to indicate on the map where the boundary is between the different CO service areas that make up the exchange. The telephone company has this information available from its Wire Center Maps. Also, in the case of a multi-CO exchange, ask the telephone company if each CO can be handled independently in designing a 911 system or whether the whole exchange must be considered a single unit.

There are other cases in which a part of a CO area can be engineered into (or out of) a 911 system independently of the rest of the CO's area. Ask the telephone company if this situation exists for any of the COs being dealt with. If this situation does exist, mark the appropriate boundaries on the map.

There are also cases where an exchange area having only one CO cannot be handled by itself but must work in conjunction with another CO because of the manner in which the telephone company has its network switching arranged. Ask the telephone company if this situation exists for any of the COs involved. If so, consider the COs involved to have one common boundary.

These questions regarding CO service areas can be very important because the "building blocks" that define the geographical area covered by a basic 911 service system are the CO service areas or, in special cases, parts of CO service areas that technically can be handled as individual entities. These CO areas are called "building blocks" because all calls made by dialing the digits "9-1-1" in a given CO area must be answered at one and only one location. The answering location, however, does not have to be physically within the CO area. To have 911 calls coming from a given CO area directed to different answering locations based on a caller's location requires the implementation of an advanced form of 911 service known as selective routing. The design of selectively routed 911 systems is discussed in Chapter III.

The next step in the design of a 911 system is to copy the telephone company CO boundaries onto the same common map that now has all of the public safety agency boundaries and dispatch center locations.

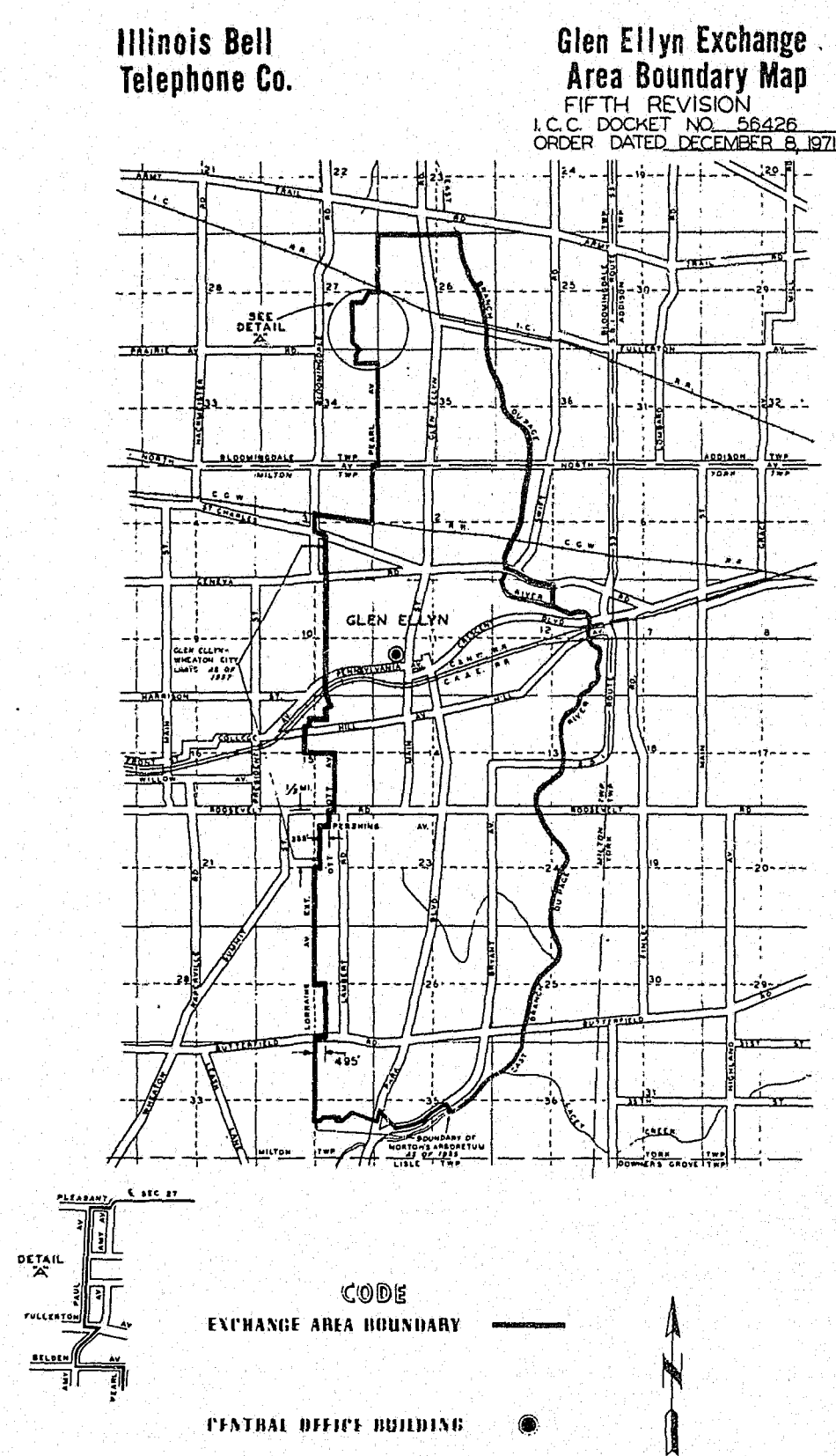


FIGURE 2 EXAMPLE OF AN EXCHANGE AREA BOUNDARY MAP

Make certain that the telephone company CO areas on this map cover all of the area served by the local public safety agencies for which the 911 system is being designed. Next, make certain that all of the area covered by the CO maps also is covered by maps of all existing local public safety agencies, including those that may not be interested in implementing 911 service. All of this information is required to evaluate effectively the extent of the mismatch between the telephone company and public safety agency boundaries.

At this point there will be a common map indicating: (1) the boundaries of all telephone company COs involved, (2) the boundaries of all public safety agency service areas which coincide with the areas covered by the telephone company maps, and (3) the location and name of each public safety dispatch center. If this common map contains so many boundary lines that it is difficult to follow, then the information should be put on two different maps: one map showing the telephone company and law enforcement agency boundaries, and the other showing the telephone company, fire protection, and emergency medical agency boundaries.

The boundary of the prospective 911 area now is defined by the outside boundary made by the telephone company CO areas as a group. The next step in designing the system is to analyze the extent of the boundary mismatch between the telephone company CO boundaries and the public safety agency service area boundaries. The purpose of this boundary mismatch analysis is to determine if all COs shown on the common map will become part of the 911 system, and if this area should comprise a single 911 system or more than one 911 system. The results of this analysis also will indicate the logical alternative locations of the Public Safety Answering Points (PSAPs). Each variation in system boundary or PSAP location that is to be investigated constitutes an alternative that must be designed separately.

To assist the boundary mismatch analysis, it is suggested that a table of information be developed using the boundary information from the common map. In this table, for each CO or piece of a CO that can be manipulated as an individual entity, list the name of each public safety agency whose territory is served in whole or in part by the CO. Include in this list, as applicable, the names of the local state police/patrol and state forestry units, as well as any federal fire protection unit that might be serving the area. Also consider including poison control centers, suicide prevention centers, crisis centers, university or college emergency services, Coast Guard facilities, or any other emergency resources that persons living in the CO area might have need to call in an emergency. Next, in the last column of the table, opposite each agency, write the name of the dispatch center from which that agency's mobile units are dispatched. Refer to Table 1 for a sample of this table. The third column, referring to call volume (shown in Table 1) will be explained later in the design procedure.

Table 1

SAMPLE OF A TABLE FOR LISTING THE EMERGENCY SERVICE AGENCIES THAT ARE SERVED BY EACH TELEPHONE COMPANY CENTRAL OFFICE AREA

Central Office Name	Emergency Service Agencies	Average Busiest-Hour Call Volume	Agency Dispatched By
(Name of CO #1)	(Name of each emergency service agency whose jurisdiction receives telephone service from CO #1)	(Estimated number of calls that each agency listed in the second column will get from CO #1)	(Name of the dispatch center serving each agency listed in the second column)
(Name of CO #2)	(Name of each emergency service agency whose jurisdiction receives telephone service from CO #2)	(Estimated number of calls that each agency listed in the second column will get from CO #2)	(Name of the dispatch center serving each agency listed in the second column)
Note: Continue developing this table until all central office (CO) areas on the common map have been included. Several of the emergency service agencies may be listed for more than one CO.			

This table not only will help in analyzing the boundary mismatch problem, but also will show all involved agencies and political jurisdictions the degree of complexity that must be dealt with in designing a 911 system. This becomes especially important when many agencies and municipalities are involved.

As mentioned earlier, the building blocks of the area covered by a basic 911 service system are the telephone company CO service areas. The next step in defining the system boundaries is, then, to determine where the calls originating from each CO should be answered.

The principal objective of 911 service is to provide a system whereby anyone can contact the correct agency rapidly in an emergency. To accomplish this, the number of 911 calls that require a caller to be transferred, or that require caller information regarding an incident to be relayed, should be held to a minimum. In most areas of the country, the majority of calls using emergency telephone numbers (approximately 80% to 90%) are directed to law enforcement agencies. Therefore, areas served by law enforcement agencies (or more correctly the areas served by law enforcement dispatch centers) normally control the location of the PSAP and, therefore, the boundary of the system.

This is not to say that law enforcement agencies receive the highest portion of emergency calls compared with other services such as fire, emergency medical, etc. Many calls to law enforcement agencies do not require emergency response or are referred directly to other organizations. However, with respect to 911, the meaning of "emergency" depends on the caller's perception rather than the agency's. Therefore, regardless of how emergency functions are apportioned by the local governments, the public seems to want to call the police in the large majority of cases.

The PSAP does not have to be located at a law enforcement dispatch center, even though that is where most PSAPs are located. The PSAP can be located (and some are) almost anywhere--a fire department, a hospital, an ambulance company, a civil defense center, a motel, a telephone company, city hall, the county courthouse, or an individual's home--as long as someone is there 24 hours a day, seven days a week to answer and process 911 calls. However, in the remainder of this section, it will be assumed that it is desired that the PSAP be collocated with a law enforcement dispatch center.

Using the common map showing all CO and agency boundaries, the law enforcement agency population estimates, and Table 1, the following process can be used to choose the PSAP location to serve each CO area. Write on the table, next to each local law enforcement agency's name, the estimated population that that agency is responsible for in the particular CO's area. Do this for all local law enforcement agencies and CO areas that are being considered, even though only a small part of an agency might overlap a particular CO's boundary. The PSAP location now is chosen on the basis of which law enforcement dispatch center (the third column in the table) serves the largest population in a given CO area. If more than one of the law enforcement agencies being served by a given CO are dispatched from the same dispatch center, then combine these agencies' estimated populations to determine which dispatch center is serving the greatest population and, therefore, which should be the PSAP. Population figures can be used in this process instead of actual call volumes to determine PSAP location, because there is a close correlation between population size and calls for emergency service.

The end result of the above process may show that a PSAP should provide 911 service to more than one CO area. This will happen if there is a particular law enforcement dispatch center serving a majority of the population in more than one CO area.

If analysis of the boundary mismatch situation does not show a clear choice of a PSAP location to serve a particular CO area, then each of the possible PSAP locations should be investigated as a separate alternative. An important factor to consider when faced with this situation is the impact on the fire protection and emergency medical agencies that are also involved. Generally speaking, the law enforcement dispatch center PSAP should be chosen on the basis of how effectively fire and medical 911 calls are handled. This type of analysis

usually is performed as part of a cost-effectiveness analysis (discussed in Section V-C).

When it has been decided which CO areas will form a 911 system for a particular alternative, add the CO names to Table B-1 in Appendix B. Use an additional sheet if necessary.

If the 911 system is being designed for a low-population area that perhaps does not have a public safety dispatch center manned at all times, the system can be designed so that the same incoming 911 lines are connected to more than one location. If this method is used, the locations should be chosen so there would be someone at one of the locations at all times. The 911 lines would ring at each location at the same time and would be answered at whichever location was manned.

Using fewer PSAPs than are indicated by the above analysis would result in more 911 calls being transferred than is necessary or desirable. The reverse is also true. Consolidation of dispatch facilities might reduce the number of required PSAPs and the number of transferred 911 calls.

The procedure presented in the remainder of this chapter is directed at the design of a specific 911 system. If the area being considered has more than one PSAP or alternative locations to be investigated, the PSAPs must be addressed one at a time throughout the remainder of the design process.

Now that the PSAP location has been chosen and the boundary of the 911 system has been defined, the next step is to determine which agencies will have some or all of their 911 calls answered by the PSAP. The easiest way to do this is to develop a second type of table using the information in the first table that was developed.

In this second table, list the names of the emergency service agencies that will have some or all of their 911 calls answered by the PSAP. Also, as in the case of the first table, list the names of the dispatch centers that serve each of these agencies. Refer to Table 2 for a sample of this table. The last three columns, referring to call volumes (shown in Table 2), will be explained later in the 911 system-design procedure.

The second table not only will help ensure that all emergency service agencies--local, state and federal--are accounted for, but also will be used later to assist in the design process.

Table 2

SAMPLE OF A TABLE FOR LISTING THE EMERGENCY SERVICE AGENCIES THAT ARE SERVED BY EACH PSAP AND THE ESTIMATED CALL VOLUMES

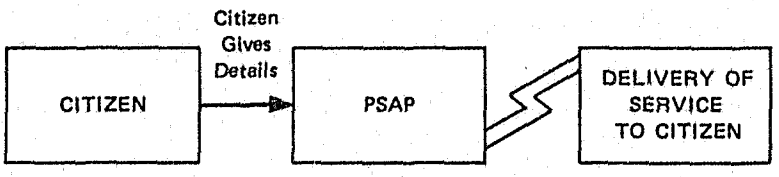
Emergency Service Agencies	Agency Dispatched By	Call Volume In Busiest Hour of Each Shift		
		Swing	Night	Day
(Name of each emergency service agency that would have all or some of its 911 calls answered by the PSAP)	(Name of the dispatch center serving each of the agencies listed in the first column)			
Note: Be sure to include the agencies that are dispatched from the PSAP location in the list of emergency service agencies.				

C. System Operation

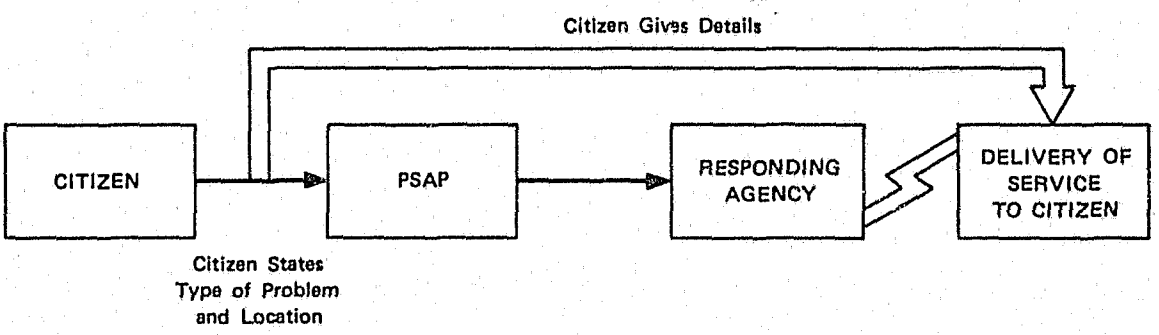
The next major step in designing a 911 system is choosing the operational method by which each agency's 911 calls will be handled. This must be done before the required type and number of telephone system components can be determined.

The primary function of a 911 system is to facilitate the flow of information between a caller and the proper emergency agency, thereby minimizing the time required for the caller to receive emergency service. The 911 system simplifies the task of the caller (reduces the number of decisions that the caller must make) and increases the responsibility of the operators of the public safety communications system. The procedure for routing information to the proper agency, however, varies with the jurisdictional, operational, and organizational requirements of the area being served.

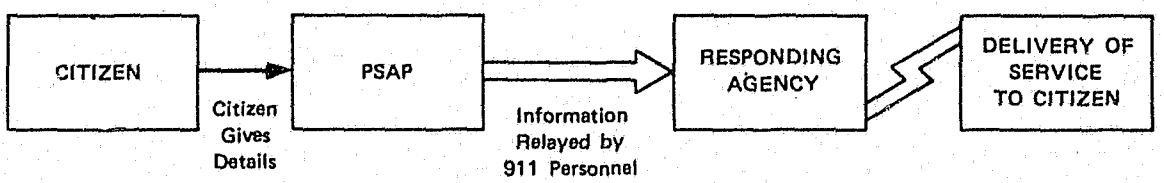
The remainder of this section will be devoted to describing the four basic 911 call handling methods--direct dispatch, call transfer, call relay, and call referral. The information flow for each of these operational methods is illustrated in Figure 3.



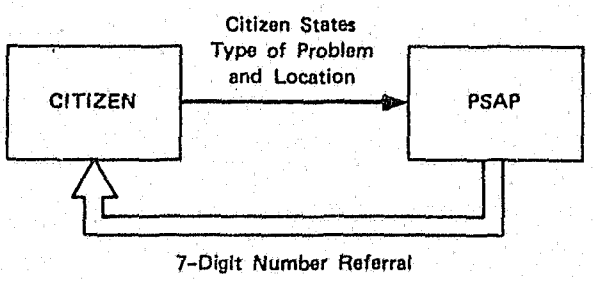
(a) DIRECT DISPATCH



(b) CALL TRANSFER



(c) CALL RELAY



(d) CALL REFERRAL

FIGURE 3 911 OPERATIONAL METHODS

1. 911 operational methods. Most 911 systems use two or three of these four methods to handle variations in levels of cooperation, centralization, and consolidation between the participating agencies, as well as local boundary mismatch problems. Several state 911 laws specify the minimum number of call handling methods that must be incorporated into the system design.

a. Direct dispatch. In the direct dispatch method, the two principal emergency communications system elements--911 call answering and the responding agency's dispatch center--are collocated at the PSAP. For example, the answering center might be collocated with a centralized multiagency dispatch center handling emergency calls for police, fire and emergency medical service, or it might be operated in conjunction with a single agency providing one type of emergency service. The PSAP also could be at a location that has no radio dispatch activity. Transmission of information from the PSAP to any of the agencies not collocated with the answering center can be achieved by using either one or a combination of the remaining three basic operational methods: call transfer, call relay, or call referral.

If there were no boundary mismatch between telephone COs and public safety agency jurisdictions, and if all emergency communications--police, fire, and emergency medical--could be dispatched from a single location, there would be no need for any other 911 operational method. Direct dispatch would be universal. For many reasons--operational, technical, and political--a single location for call answering and dispatch is not feasible in most cases.

b. Call transfer. As shown in Figure 3, call transfer requires that the citizen first dial 911 to reach the PSAP. The PSAP call answerer then obtains, as rapidly as possible, information describing the location and nature of the problem and determines which emergency service agency should respond to the incident. Then the PSAP connects the caller to the proper agency.

The major advantage of call transfer is the lack of interagency coordination necessary after 911 implementation. Call transfer has two major disadvantages. First, the response time is longer than that of the direct dispatch method. Second, the caller must repeat parts of the incident details, a problem that is often frustrating to a caller under stress. Even with these two disadvantages, the individual response time, in most cases, still is considerably less (better) than with the present seven-digit-number emergency system. The training of the PSAP call answering personnel makes them more familiar than telephone company operators with the responsibilities of individual local public safety agencies.

c. Call relay. Call relay is similar to call transfer in the facilities required. In call relay, however, the information rather than the caller is transferred to the proper agency. The total information is obtained from the caller by the PSAP and relayed to the proper dispatch center. The caller does not notice any difference between call relay and direct dispatch because the PSAP relays the information to the proper agency, and the caller is spared the necessity of repeating incident details. Call relay also is used sometimes when a caller hangs up before they can be transferred to the proper agency.

The major advantage of call relay is that response time is essentially the same as that of two-stage (separate call answerer and dispatcher) direct dispatch, and caller frustration is minimized. Call relay also has the advantage of leaving dispatch operations under the control of individual agencies, who view the dispatch function as a management and control function rather than a more neutral "resource allocation" function. A disadvantage of call relay is that proper operation requires explicit call answering policies for the various agencies. This necessitates a degree of cooperation which many agencies find difficult to achieve.

d. Call referral. The call referral method, in which the PSAP provides the citizen a seven-digit number to dial, is used for two purposes. First, there may be certain emergency or quasi-emergency agencies to which the PSAP, for some reason, may be unable to transfer calls. Second, the public should be discouraged from using 911 for non-emergency calls so as to keep the lines free for emergency calls. Therefore, call referral is also a means of informing the public, in a polite and professional manner, that they should not use 911 except for emergencies.

Some states which have mandatory 911 system operational standards specifically prohibit using the call referral method for emergency calls.

2. Selection of call handling method. Before more of the technical system design process takes place, a preliminary decision must be made as to the primary operational method for routing 911 calls or information to each involved emergency service agency from the PSAP. Selecting the appropriate 911 operational method is normally not much of a problem. The choice of the call handling method usually is made by each individual agency for whom the PSAP is answering 911 calls.

Agencies selecting the call transfer method or call relay method also will have to make a decision as to whether private tie lines or nonpublished seven-digit number lines will be used (discussed in Section II-E). The decision on the type of transfer lines will have an impact on the type and size of call answering and transfer equipment that is required at the PSAP (discussed in Section II-F).

In all cases, call-relay can be used as the main backup method of operation. Call referral can be used as the secondary backup method.

D. Optional Telephone Service Features

Most 911 systems may be equipped with one or more optional service features which are designed to improve the quality, speed, and accuracy of the PSAP response. These features are limited by the telephone companies' capability to provide them.

1. Description of optional features. The principal optional service features, their purposes, and line requirements are discussed in the following eight subsections, and are summarized in Table 3.

a. Called party hold. The called party hold feature enables the PSAP to maintain a 911 call connection, even if the calling party has hung up, so that the call can be traced by the telephone company. This is a useful feature in locating individuals who hang up before providing the PSAP with sufficient information regarding an emergency situation, or who make "crank" or threatening calls. Called party hold can be provided only when the incoming 911 lines to the PSAP are direct dedicated (private line) trunks. This feature cannot be provided if the 911 lines are tandem (network switched) trunks.

b. Forced disconnect. Forced disconnect is a feature that enables the PSAP call answerers to release a connection (hang up and have the line cleared) on a 911 call, even if the calling party has not hung up. The time required for the forced disconnect varies with telephone central office switching equipment, but is generally between 10 and 30 seconds. This feature prevents intentional jamming of the 911 lines by persons who dial 911 and refuse to hang up. Forced disconnect can be provided using either direct dedicated or tandem trunked 911 lines.

c. Ringback. Ringback is a feature that allows the 911 call answerer to call back the caller after the caller has hung up, even if the PSAP does not know the caller's telephone number. This feature is used when a caller does not give enough information about an emergency being reported. If the caller is on a multiparty line, operating the ringback feature also will ring any additional parties on that line. The 911 lines must be equipped with the called party hold feature in order to have ringback. This means that the 911 lines must be direct trunked.

d. Idle circuit tone application. Idle circuit tone application is a feature that provides a means of determining, upon answering a call, whether the calling party already has hung up, or whether the caller is still on the line but is unable or unwilling to speak.

Table 3

SUMMARY OF OPTIONAL TELEPHONE SERVICE FEATURES AND THEIR PREREQUISITES

Feature	Description	Prerequisite
Called Party Hold	Enables the PSAP to hold a call, even if the caller hangs up. Permits the call to be traced.	Direct trunking
Forced Disconnect	Enables the PSAP to clear a 911 line, even if the caller does not hang up. Prevents intentional jamming of 911 lines.	None
Ringback	Enables the PSAP to call (ring) back a caller after the caller has hung up. Useful if the caller did not give enough information before hanging up.	Direct trunking Called Party Hold
Idle Circuit Tone Application	Enables the PSAP to tell whether a caller already has hung up, or whether the caller is still on the line but is unable or unwilling to speak.	None
Switchhook Status Indication	Enables the PSAP to tell whether a caller is on hold or has been disconnected. Ensures that a caller's line is not held up unnecessarily.	Direct trunking
Automatic Number Identification	Enables the automatic display at the PSAP of the seven-digit telephone number of the telephone used to place the 911 call.	Direct trunking
Automatic Location Identification	Enables automatic display at the PSAP of the address of the telephone used to place the 911 call.	Direct trunking ANI

If the caller hangs up just before the PSAP answers, a distinct tone is applied to the PSAP. If the caller is still on the line, no tone will be heard. This feature can be provided using either direct trunked or tandem trunked 911 lines.

e. Switchhook status indication. The switchhook status indication feature provides the PSAP call answerer with audible and visual indications of whether a 911 call which has been received and put on hold is still on hold or has disconnected. This feature would help ensure that a caller's line is not held up unnecessarily after the emergency call is completed. The main value of this feature would be realized if the PSAP also had the called party hold feature. This feature can be provided only when the 911 lines are direct trunked. Special equipment (at additional cost) might be required at the PSAP before this feature could be provided.

f. Automatic number identification. Automatic number identification (ANI) enables display of the seven-digit number of the telephone used to place the 911 call at the PSAP call answering positions (and sometimes at the locations that have 911 calls transferred to them). ANI removes the need for the called party hold, ringback, and switchhook status indication features. Direct trunked 911 lines are required to provide ANI.

This advanced optional feature normally costs considerably more than the previous features that have been discussed.

g. Automatic location identification. Automatic location identification (ALI) enables display at the PSAP call answering positions of some or all of the following information: the seven-digit number of the telephone used to place the 911 call; the street address or other indication of geographical location of the calling telephone; codes indicating the law enforcement, fire protection, and emergency medical agencies serving that telephone's location; a code to indicate that a pay phone was used; a code to indicate that a foreign exchange line was used; and a code to indicate that the call might be originating from an off-premises PBX station (i.e., the address given might not be correct). Direct trunked 911 lines are required to provide ALI, and ALI can be provided only if ANI has been implemented.

If ALI is being considered for implementation, ask the telephone company what type of information it can supply with the ALI feature. Additional useful codes or other information might become available as more experience with ALI is gained. As in the case of ANI, ALI costs considerably more than the other optional features.

h. Dial tone first. Dial tone first (DTF), or coin-free dialing, allows a caller to dial 911 from a pay telephone without depositing coins. Strictly speaking, DTF is not an optional service feature. Because of its potentially high cost (depending on the number of telephones involved), it is not something that normally would be ordered with 911 service. A number of states that have passed 911 legislation require telephone companies to implement DTF by a specified time without direct charge to the local governments being served by 911. The implementation of DTF has no direct effect on the design of a 911 system other than the potential increase in the number of 911 calls (a result of increased 911 availability).

2. Selection of optional features. The selection of optional 911 features usually is made by a consensus of the emergency service agencies that will be served by the system. When making this decision, two things should be considered: the impact on the overall operation of the 911 system by the PSAP, and the impact on dispatch centers that receive their 911 calls from the PSAP by the call transfer method.

The impact on the PSAP and system operation is clear from the descriptions of the optional features given in Section II-D-1. The potential benefit to a dispatch center of maintaining control of certain optional features is also clear. However, for a dispatch center to receive control of such features as called party hold, forced disconnect and idle circuit tone application, the dispatch center must receive its transferred calls over private tie lines (more expensive than other methods), and special call-answering and transfer equipment (sometimes more costly than standard equipment) must be used at the PSAP.

The final selection of optional features, and their control by a dispatch center, can be decided by looking at alternatives and evaluating them in a cost-effectiveness analysis (discussed in Section V-C).

Indicate in Table B-3 of Appendix B those telephone service features that have been selected to be designed into the 911 system. Some of the features listed in Table B-3 are available only with selective routing (discussed in Section III-D).

E. Telephone Lines

The point in the design procedure now has been reached where the required number of each type of telephone line (trunk) can be determined. This section of the manual describes the various types of telephone lines that might be used in a basic 911 service system. A description of data required at this point in the 911 system design phase and the method used for computing the number of lines also are given.

1. Types of lines and their uses. Three basic types of telephone lines may be used in a basic 911 service system: incoming 911 lines, private tie lines, and seven-digit-number lines. Each of these three types is described below in terms of its use in a 911 system.

a. Incoming 911 lines. The incoming 911 lines are the telephone lines over which 911 calls are routed to the PSAP from the telephone company COs. These incoming 911 lines can be provided using either direct trunking or tandem trunking. In tandem trunking, all 911 calls are routed by whatever means the telephone company chooses, and with as many lines as required, from each telephone CO in the 911 system to the CO to which the PSAP is directly connected. The PSAP then leases the necessary number of lines between its serving CO and the PSAP. In direct trunking, the PSAP leases dedicated private lines that directly connect each CO with the PSAP.

Direct trunking is usually more expensive than tandem trunking when the 911 system is comprised of more than one CO. This is because direct trunking normally requires more telephone lines than tandem trunking, and because different telephone service tariffs are applied to the two methods. In a large system, direct trunked 911 lines can cost several times more than tandem trunked lines.

The 911 lines are arranged for one-way calling only--from the public to the PSAP. Calls cannot be made from the PSAP over the 911 lines.

When making the decision on whether to implement direct or tandem trunking, cost is not the only factor to consider. The following two factors also should be considered: the implementation of certain optional telephone service features requires that direct trunking be used (refer to Section II-D-1), and when a 911 system is comprised of two or more COs, direct trunked lines may be hardwired through all intermediate COs. This increases 911 system survivability if one of the intermediate COs suffers a power failure or minor damage.

If the 911 system has more than one CO, another benefit of direct trunking is that each incoming 911 line to the PSAP can be labeled as to which CO area it is coming from. This would enable the call answerer to narrow down the area in which the caller is located and thereby to determine which agency should respond. This sometimes is called "central office identification".

The vast majority of the existing 911 systems use direct trunking for the incoming 911 lines. If direct trunking is selected for implementation, applicable mandatory state standards will need to be checked. Some states require a minimum of two incoming 911 lines from

each CO when direct trunking is used. If tandem trunking is being considered, ask the telephone company if it can provide tandem trunking, as some do not.

b. Outgoing private tie lines. Outgoing private tie lines from the PSAP provide a means for 911 call answerers to transfer callers to the radio dispatch center, or other source responsible for providing emergency assistance. Private tie lines also can be used to connect adjacent PSAPs for use as coordination channels in the event of a common emergency affecting two adjacent 911 system areas.

These private tie lines sometimes are called "hotlines." The line begins to ring at the other end as soon as the line is accessed by pushing a button or picking up a phone, depending on the system's design. These lines are also two-way lines; a call can be initiated from either end.

Deciding on the need for a private tie line between the PSAP and any particular location generally is based on two factors: the estimated volume of calls that would go over the line, and the cost for the line. Private tie lines are also faster and less subject to CO switching delays than are seven-digit-number lines (discussed in the following subsection). If a particular dispatch center receives several calls from the PSAP during its average busiest hour of the day, then one or more private tie lines are probably justified. In terms of cost, private tie lines are more expensive than using nonpublished seven-digit-number lines. Also, the longer these private lines are, the more they cost.

The primary factor in deciding on private lines is whether or not the cost of a private line is justifiable to the agency that will pay for it. If in doubt, ask the telephone company to provide costs for both private tie lines and seven-digit-number lines.

When it has been decided which dispatch centers will be connected to the PSAP by private tie lines, add the names of these dispatch centers to Table B-1 in Appendix B. Use an additional sheet if necessary. The control office transfer lines referred to in Table B-1 are used with selective routing (discussed in Section III-E).

c. Seven-digit-number lines. The most common uses for seven-digit-number lines are for call transfer, call relay, telephone company operator access, backup, and as an administrative number.

Nonpublished seven-digit-number lines sometimes are implemented so the PSAP can transfer callers or relay information (using the public switched telephone network) to dispatch centers that do not receive enough emergency calls from the PSAP to warrant the expense of a private tie line. As discussed in the preceding subsection, the choice between a private line and nonpublished seven-digit-number line is

made by considering need, cost, and agency desire. The telephone equipment needed at the PSAP to accomplish the transfer or relay of calls is addressed in Section II-F.

Dispatch centers receiving their calls from the PSAP over the public network (as opposed to private tie lines) would receive them on their existing published seven-digit emergency number lines. If a dispatch center has these old emergency numbers disconnected when the public stops using them, a nonpublished seven-digit number will have to be implemented so that the PSAP can gain access to the dispatch center for call transfer or call relay.

Telephone company operators normally do not have the capability of transferring onto 911 lines the emergency calls that are made to them. Therefore, the PSAP should have a nonpublished seven-digit number which telephone company operators can use to transfer emergency calls to the PSAP (if the operator is not certain which agency should receive the call).

Any of these nonpublished numbers also can be used by adjacent PSAPs or other emergency service agencies (at the PSAP's discretion) for emergency communications with the PSAP. In the event of a tie line failure or overload, agencies connected to the PSAP by a tie line also could receive their emergency calls over a nonpublished number dial-out line.

Each PSAP also should have a published seven-digit number for general administrative use. If desired, this number can be the same administrative number that is used by the agency where the PSAP is located. It also would be possible to dial-out transfer a call using the administrative line if all other lines were in use or had failed for some reason.

As discussed in Section II-D-2, it is not possible to transfer control of any optional features with a call that is transferred over seven-digit-number lines.

2. Data needed to compute number of lines. To calculate the required number of telephone lines needed to handle traffic between two locations, values must be obtained or assumed for the four following parameters: grade of service, ringdown time, average call length, and average busiest-hour call volume. Each of these items is discussed below.

a. Grade of service. The number of required telephone lines is computed on the basis of a particular grade of service. Grade of service is the probability that a caller will get a busy signal when calling a particular number. This probability is expressed as a decimal that usually means the busy-hour probability. The most common grade of service used in the design of emergency telephone systems is P.01. This

means that no more than one call out of 100 made during the average busiest hour of the day should receive a busy signal. During the remainder of the day, the chance of getting a busy signal would be much less.

Before selecting a grade of service, be aware that some states that have mandatory 911 system standards specify the minimum grade of service to which the system must be designed.

b. Ringdown time. The length of time that a phone rings before it is answered is called ringdown time. This factor affects both the number of telephone lines and the number of 911 call answerers that are required at the PSAP. There is currently no established standard used in computing the required number of lines. There are, however, standards for ringdown time when computing numbers of 911 call answerers (discussed in Section II-G-2). Consequently, the same ringdown time used to compute the number of call answerers also should be used to compute the number of incoming 911 lines to the PSAP.

The ringdown time that is chosen for design purposes, if not mandated by state standards, depends on the level of service that local agencies can provide. The most commonly used ringdown time is the time it takes for two or three rings of the telephone. This typically takes about 10 s, depending on the type of CO equipment involved.

c. Average call length. The length of an emergency telephone call varies with a number of factors such as the type of emergency, the service policies and techniques of the agency being contacted, and the individual characteristics of both the calling party and the call answerer. Several different measurable periods of time (discussed below) may be involved when determining call lengths to be used in computing the number of required lines. This average call length data also will be used in determining PSAP call answerer requirements (discussed in Section II-G-3). These individual times must be determined before preceding with the line calculations.

One of these periods of time is the maximum ringdown time that has been chosen (discussed in the preceding subsection). Even though no one is talking on it when a line is ringing, the line still is occupied.

Another period of time to be determined is the average time that a caller takes to report an emergency to a law enforcement agency. Even though some callers hang up too soon and some are kept on the line purposely until a mobile unit arrives at the caller's location, an average time must be determined and used. An average law enforcement call typically takes from 1 to 1 1/2 minutes (mins). This average time can be determined by asking operating personnel at local law enforcement dispatch centers that would be served by the PSAP.

Two other considerations in determining average call length are the times it takes a caller to report a fire or a medical emergency. The average times for these calls are normally less than for a law enforcement call. Typically, they average from ½ to 1 min. These times can be determined by asking operating personnel at the fire and emergency medical dispatch centers.

A final factor to be considered is the time it takes to transfer the call. A 911 line is occupied while the calling party is waiting to be transferred; a 911 system should be designed so that this transfer process takes a maximum of 30 s. This time should include initial screening by the PSAP. An efficient PSAP can accomplish the transfer process in an average of 15 to 20 s.

The procedure presented in Section II-E-3 shows how these different periods of time are used to compute line requirements for the various types of lines.

d. Call volume. In computing the number of telephone lines that are required, the estimated call volume of the average busiest hour of the week is used. The average busiest hour for a particular agency is that one-hour period during the week in which the agency usually receives the most telephone calls requesting emergency assistance.

Law enforcement agencies almost always have a predictable average busiest hour which, in most cases, occurs on the swing (evening) shift on a Friday or a Saturday. Some emergency medical agencies also have a predictable busiest hour. Fire protection agencies rarely have a predictable average busiest hour unless they also are providing emergency medical service to their communities.

Two different approaches--a very detailed approach and an approximation method--for determining average busiest-hour call volumes are discussed below. The detailed approach is discussed first.

Determining the average busiest-hour call volumes for use in 911 system design purposes is a three-step process. First, personnel at each dispatch center and each other involved emergency service agency must be asked which hour is their average busiest hour. It is possible that all agencies with an average busiest hour do not have identical average busiest hours. Therefore, the second step is to ask personnel at each dispatch center and other involved agencies how many calls for service they usually get during each of the hours that are candidates for the overall busiest hour. This means, for example, that if a decision has to be made as to which of three different hours is the overall busiest hour, ask personnel at each dispatch center and the other agencies how many calls are usually received in each of these three hours.

The third step is to total up the call volumes for each of the hours being considered. Select the one hour that has the highest volume of calls as the overall 911 system average busiest hour.

Emergency telephone systems, unlike radio systems, normally are not designed to handle unpredictable, extraordinarily high volumes of calls. When requesting the average busiest-hour call volume estimates, therefore, be sure not to consider those situations such as severe storms, sonic booms, disasters, etc., that can cause a higher-than-normal volume of calls. If, however, an agency is subject to a predictable seasonal variation in the number of emergency calls it receives, such as might occur in an area having a large number of tourists or periods of high susceptibility to fires, it should determine its average busiest-hour call volume from the busy season. Also, if a dispatch center serves more than one agency, ask that the average busiest hour and its call volume be estimated separately for each individual agency.

Those agencies that normally receive a very low overall volume of calls, or that have an unpredictable weekly average busiest hour, also must be considered. The simplest way to deal with this situation is to assume that each of these agencies will receive one or two calls in the busiest hour from each CO area that is providing service to the agency. It is likely that when these agencies do have their busy periods, these periods will not coincide with the 911 system's average busiest hour and there should be enough 911 lines to handle the calls.

Now that the average busiest-hour call volumes are known for each agency, this information must be organized so that it can be used easily. The overall 911 system busiest-hour figures will be used to compute the number of incoming 911 lines to the PSAP. Individual dispatch center and agency call volumes will be used to compute the number of private tie lines and nonpublished seven-digit-number lines that are required.

To compute the required number of lines, the number of calls that are expected from each individual CO must be estimated. This is accomplished by using the common map (refer to Section II-B), the two tables (Tables 1 and 2 in Section II-B), and the individual agency average busiest-hour call volume estimates.

Look at each CO and agency boundary overlap shown on the map, together with the agency's busiest-hour call volume estimate, and determine (based on the population served) how many of the busiest-hour calls each agency would get from each CO area. Write this estimated number of calls in the third column of the first table.

Next, transfer the call volume information, individually or combined (the PSAP may serve more than one CO) as necessary, to the appropriate column of the second table. For example, if the overall busiest hour is in the swing shift, use the column label "Swing."

Use of the other two columns will be explained when describing how to compute personnel requirements (The exact manner in which all of this information is used is discussed in the next subsection).

In the approximation approach to determining average busiest-hour call volumes, the following assumptions can be used to derive a reasonable estimate. The average busiest-hour call volume that the PSAP would receive if the area to be served is urban, or mostly urban, is equal to approximately 0.31 calls for each 1,000 population being served by the PSAP. This factor of 0.31 was derived empirically, as were the following call distribution data: (1) there will be about two emergency calls per 1,000 population on an average day; (2) a busy day is typically about 40% busier than an average day; (3) there will be an overall increase of 10% in the number of calls that are received because of greater public use of 911; and (4) approximately 10% of the day's total call volume occurs in the busiest hour of the day. Therefore, 2 times 1.4 times 1.1 times 0.1 equals 0.308. Rounding off gives the figure 0.31.

For example, this means that if the 911 system is being designed to serve an urban population of 24,600 persons, the average busiest-hour call volume would be 0.31 times 24.6 which equals 7.63. Since call volume numbers should be rounded up, the emergency call volume for design purposes would be 8.

The multiplying factor for areas that are rural, or mostly rural, is 0.15 instead of 0.31. The difference results from empirical data which indicates that there will be approximately one emergency call per 1,000 population in rural areas (instead of two calls as in urban areas).

In developing the factors 0.31 and 0.15 discussed above, a 10% overall increase in emergency calls resulting from the implementation of 911 has been assumed. Predicting the increase in calls for a given area is difficult, if not impossible in some cases. Some 911 systems have not experienced any increase in calls over pre-911 levels. Other systems have experienced fairly large increases (up to 25%). However, a good average number to use, if no better estimate is available, is 10%. The actual increase in call volume that a 911 system might experience is dependent to a large extent on the public education program that is used.

Before following one of the two approaches described above, read Section II-G-2-c of this manual. Similar work will have to be done to determine the busy-hour call volumes on the other two shifts for use in estimating call answerer staffing requirements.

3. Procedure for computing number of lines. In this section, the equation used to compute telephone line requirements is presented and explained. Specific instructions are given individually for computing the number of incoming 911 lines, private tie lines, and nonpublished seven-digit-number lines.

a. Equation for computing number of lines. To compute the number of lines required to service a particular busy-hour call volume, the call volume data first is converted into hundred call-seconds (CCS). The formula for this computation is:

$$CCS = \frac{(\text{number of busy-hour calls}) \times (\text{average holding time})}{100}$$

where

Number of busy-hour calls = the busy-hour call volume that the lines are being designed to handle,

Average holding time = weighted call length (in seconds) + ringdown time (in seconds),

and where

Ringdown time (in seconds) = (is discussed in Section II-E-2-b),

Weighted call length = Modified average call length (in seconds) (discussed below).

Since 911 PSAPs usually receive a mixture of law enforcement, fire protection and emergency medical calls--each with a different average call length--a modified average call length known as a weighted call length must be determined and used in the above equation. The weighted call length is calculated by multiplying the number of each different type of call by the average length of time that each type of call occupies a line. The sum of these multiplications then is divided by the total number of calls. Calculation of weighted call length is illustrated in the following subsection.

After the CCS is computed, its value then is looked up in standard telephone trunk (line) capacity tables that show the required number of lines for various CCS values and grades of service. Table 4 contains excerpts from the trunk capacity tables for seven different grades of service.

The actual numbers that should be used in the above equation when computing the required number of 911 lines, private tie lines, and nonpublished seven-digit-number lines are explained and illustrated in the following three subsections (II-E-3-b, c, d).

Table 4

TELEPHONE TRUNK CAPACITY TABLE

Number of Lines	Hundred Call-Seconds (CCS) per Grade of Service						
	P.001	P.005	P.01	P.02	P.03	P.04	P.05
1	0.1	0.2	0.4	0.7	1.1	1.5	1.9
2	1.6	3.7	5.4	7.9	9.7	11.3	12.9
3	6.9	12.2	15.7	20.4	24.0	26.9	29.4
4	15.4	24.2	29.6	36.7	41.6	45.7	49.1
5	26.6	38.9	46.1	55.8	61.6	66.6	70.9
6	40.0	55.4	64.4	76.0	82.8	89.3	94.1
7	54.7	73.4	83.9	96.8	105	112	118
8	70.9	92.5	105	119	129	137	143
9	88.2	113	126	142	153	162	169
10	107	134	149	166	178	188	195
11	126	156	172	191	204	214	222
12	145	178	195	216	230	240	249
13	166	201	220	241	256	267	277
14	187	224	244	267	283	295	305
15	208	248	269	293	310	322	333
16	231	273	294	320	337	350	362
17	253	297	320	347	365	378	390
18	276	322	346	374	392	407	419
19	299	347	373	401	420	436	448
20	323	373	399	429	449	465	477
21	346	399	426	458	478	494	507
22	370	424	453	486	507	523	536
23	395	451	480	514	536	552	566
24	419	477	507	542	564	582	596
25	444	504	535	571	593	611	626
26	469	531	562	599	623	641	656
27	495	558	590	627	652	671	686
28	520	585	618	656	682	701	717
29	545	612	647	685	711	731	747
30	571	640	675	715	741	762	778
31	597	667	703	744	771	792	809
32	624	695	732	773	801	822	840
33	650	723	760	803	831	852	871
34	676	751	789	862	861	883	902
35	703	779	818	872	891	913	933
36	729	807	847	892	922	944	964
37	756	836	878	922	952	975	995
38	783	864	905	952	982	1006	1026
39	810	892	935	982	1013	1037	1057
40	837	921	964	1012	1043	1069	1088

b. Computing the number of incoming 911 lines. The following example illustrates how to compute the number of required incoming 911 lines. For the purpose of this example, the following assumptions are being made:

- The incoming 911 lines will be direct trunked (This means that only one CO will be considered in this example. The same procedure would be applied individually to each CO in the system).
- The estimated total number of average busiest-hour calls that the PSAP will receive from this CO is 19.
- 11 of the 19 calls will be handled by the direct dispatch method.
  - 9 of these 11 calls are for a law enforcement agency
  - 1 of these 11 calls is for a fire protection agency
  - 1 of these 11 calls is for an emergency medical agency.
- 5 of the remaining 8 calls will be handled by the call transfer method.
  - 2 of these 5 calls are for a law enforcement agency
  - 2 of these 5 calls are for a fire protection agency
  - 1 of these 5 calls is for an emergency medical agency.
- The remaining 3 calls will be handled by the call referral method.
- The average calls lengths are:
  - 60 s for law enforcement
  - 30 s for fire protection
  - 45 s for emergency medical
  - 20 s for the call transfer process
  - 15 s for the call referral process.
- Ringdown time is 10 s.
- Grade of service is P.01.

The above assumptions list all the factors--except weighted call length--that are needed in the equation for computing the number of lines. The following shows how weighted call length is calculated.

Excluding ringdown time, each type of call specified in the above assumptions would occupy a 911 line for the following amounts of time:

- Direct dispatched law enforcement calls--60 s
- Direct dispatched fire calls--30 s
- Direct dispatched emergency medical calls--45 s
- Transferred law enforcement calls--20 s for the transfer plus 60 s equals 80 s
- Transferred fire calls--20 s for the transfer plus 30 s equals 50 s
- Transferred emergency medical calls--20 s for the transfer plus 45 s equals 65 s
- Referred calls--15 s.

Therefore, in this example, since the lines will be handling nine 60-s direct-dispatched law enforcement calls, one 30-s direct-dispatched fire call, one 45-s direct-dispatched emergency medical call, two 80-s transferred law enforcement calls, two 50-s transferred fire calls, one 65-s transferred emergency medical call and three 15-s referred calls, the weighted call length for computing the number of 911 lines is:

$$\frac{(9 \times 60) + (1 \times 30) + (1 \times 45) + (2 \times 80) + (2 \times 50) + (1 \times 65) + (3 \times 15)}{19}$$

which becomes

$$\frac{540 + 30 + 45 + 160 + 100 + 65 + 45}{19} = \frac{985}{19} = 51.84 \text{ s.}$$

After rounding up the answer to the nearest whole second, the weighted call length is 52 s.

The equation for computing the number of lines now can be used with the following numbers:

- Number of busy-hour calls = 19
- Average holding time = weighted call length + ringdown time
  = 52 s + 10 s = 62 s.

Therefore,

$$CCS = \frac{19 \times 62}{100} = \frac{1,178}{100} = 11.78$$

Now, refer to Table 4 (the telephone trunk capacity table). Since a P.01 grade of service is assumed, look under the column headed "P.01" and see where 11.78 fits. As can be seen, 11.78 is more than 5.4 (the maximum CCS that two lines can handle) but less than 15.7 (the

maximum CCS that three lines can handle). Therefore three lines are required for the incoming 911 lines from the CO in this example.

If there is not enough available information to do a detailed calculation of weighted call length, then a reasonable estimate can be made by using the average call length of direct-dispatched law enforcement calls in place of weighted call length. This assumption is not valid, however, unless the PSAP is located at the law enforcement dispatch center receiving the most calls from the CO.

When calculating the required number of 911 lines, if Table 4 indicates that a small increase in call volume will necessitate adding one more line, the line should be added. This is especially true if it appears that the average busiest-hour call volume has been underestimated. The added cost of an additional line is generally small compared to total system cost. It is also better to have too many lines than too few.

When the required number of incoming 911 lines from each CO have been computed, add this information to Table B-1 in Appendix B.

c. Computing the number of private tie lines. The following example illustrates how to compute the number of required private tie lines. In this example, the following assumptions were made:

- The tie line(s) connect the PSAP with a law enforcement dispatch center.
- The average number of busiest-hour calls that the dispatch center will receive from the PSAP is 6.
- The average call length is 70 s.
- Ringdown time is 10 s.
- Grade of service is P.01.

There is no need to compute a weighted call length in this example because only one type of emergency service agency is involved. Therefore, using the equation for computing the number of lines,

$$CCS = \frac{6 \times 80}{100} = \frac{480}{100} = 4.8$$

Now referring to Table 4 under the column headed P.01, it can be seen that two lines are required.

This example shows a case where one additional line probably should be used--three lines instead of two. This is because two lines could not handle one more call in the average busiest hour and still maintain

the required grade of service. If there were seven calls instead of six, then

$$CCS = \frac{7 \times 80}{100} = \frac{560}{100} = 5.6$$

Under the Table 4 column headed P.01, 5.6 is greater than 5.4 and therefore three lines would be needed.

When the required number of private tie lines to each dispatch center has been computed, add this information to Table B-1 in Appendix B.

d. Computing the number of seven-digit-number lines. If nonpublished seven-digit-number lines are to be used for transferring calls, then one or more nonpublished telephone numbers will have to be ordered from the telephone company. The number of lines required for this purpose are computed in the same manner as shown in the examples in the preceding two subsections. The only difference is in determining the average busiest-hour call volume. This call volume is simply the total number of calls that might have to be transferred in the 911 system's average busiest hour to all agencies that are not connected to the PSAP by a private tie line. A weighted call length would be calculated as shown in Section II-E-3-b.

In addition, consideration should be given to ordering a nonpublished number for telephone company operator use. This is especially true if there will be a large number of local public safety agencies participating in the 911 system.

When the number of required published and nonpublished seven-digit-number lines has been determined, add this information to Table B-1 in Appendix B.

F. Call Answering and Transfer Equipment

Now that the method of handling each agency's emergency calls has been determined, the desired optional telephone service features have been selected, and the number of each type of required telephone line has been computed; the next step in the design process is to determine the type of call answering and transfer (terminal) equipment that is needed. This section of the manual contains a brief description of the types of terminal equipment that are most available for use in a PSAP, criteria for selecting appropriate equipment, and comments on the number of 911 call answering positions that should be equipped.

1. Types of terminal equipment. Telephone terminal equipment can be leased from the telephone company serving the PSAP, or can be purchased from an independent supplier. Since there are more than 1,500

telephone companies operating in the United States, as well as many vendors of telephone terminal equipment, there is no simple list available of the specific pieces of 911 telephone terminal equipment (and their capabilities). However, the principal broad categories of terminal equipment include handsets, pushbutton sets, switchboards, centrex, automatic call distributors, and key telephone systems.

Handsets are the common, single-line telephone instruments that usually are seen in homes and offices. Additional equipment is needed to transfer calls.

Pushbutton sets have keys (pushbuttons) usually provided in multiples of six or ten. Some types of telephone equipment that use key sets have call transfer capability and some do not.

Switchboards, generally referred to as PBXs or PABXs, are available in manual or automatic versions, and also in cord type (lever switches) or cordless (pushbutton) call answerer operation. Most switchboards are, or can be, equipped to transfer calls to other locations.

Centrex is a type of private branch exchange in which incoming calls can be dialed direct to any extension without an operator's assistance. Outgoing and intercom calls are dialed by the extension user.

Automatic Call Distributors (ACDs) are designed to distribute large volumes of incoming calls to call answerers not already busy with a call, or to hold calls until call answerers are available. Most ACDs are, or can be, equipped to transfer calls.

Key Telephone Systems consist of one or more multibutton telephone sets and associated relay equipment. These systems permit mutual access to, and control of, a common set of lines. The systems have pick-up, hold, signal, and intercommunication features.

As indicated above, some types of telephone terminal equipment are not capable of handling call transfers without additional equipment. Most telephone companies, however, have equipment to enable the call answerers to transfer calls. This equipment includes special conference-bridging arrangements, high-speed automatic (adjunct) dialers, and abbreviated dialing service.

A conference-bridging arrangement allows the call answerer to call a third party, such as a dispatch center, so that all three parties--caller, call answerer, and dispatch center--can talk together. Some conference-bridging arrangements require that the PSAP call answerer remain on the line until all parties are through talking.

A high-speed dialer (called "Touch-A-Matic" by the Bell System) is a small desk-top unit that contains preprogramed telephone numbers. The desired number is called by pushing a button which corresponds to a desired seven-digit number.

Abbreviated dialing (called "Speed Call" by the Bell System) is sometimes available when the PSAP's serving CO is of the common controlled type. The desired number is called by dialing a one- or a two-digit code. Equipment at the CO, which contains the codes and their corresponding seven-digit telephone numbers, automatically dials the correct number.

Sometimes a telephone company will develop a specialized piece of equipment for 911 system use. Two notable examples are the Western Electric (Bell System) 8A Key Telephone System, and the Answer/Transfer System (ATS) developed by the Pacific Telephone & Telegraph Co. (the Bell System Company serving California). The 8A System also has been made available to some independent telephone companies on a limited basis.

If ANI or ANI and ALI (described in Sections II-D-1-f and g) are implemented in a 911 system, then special display equipment is required. These two pieces of control and display equipment are discussed in Section III-F-1. Under certain conditions, if a PSAP is operating a computer-aided dispatching (CAD) system, it might be possible to use the CAD system's display screens instead of leasing display units from a telephone company. If this situation exists, discuss the interface requirements with the telephone company before placing an equipment order.

If a certain configuration of required equipment is not offered in a telephone company's current service tariffs, it is sometimes possible to enter into a special assembly contract with the company to have it develop special equipment. This would, of course, be an additional cost in the 911 system.

2. Selection of terminal equipment. Before the appropriate call answering and transfer equipment is selected, the requirements for this equipment should be summarized. Basic requirements can be defined by answering the questions in the next nine paragraphs.

Must PSAP terminal equipment be capable of transferring 911 calls to one or more locations?

If call transfer capability is required, will any private tie lines be used?

If call transfer capability is required, will any calls be transferred using the public switched-telephone network? If the answer to this is yes, then high-speed dialers or abbreviated dialing service might be required.

If there is to be more than one 911 call answerer on duty at one time, must each call answerer have access to all telephone lines associated with the operation of the PSAP? Several state 911 standards specify that each call answerer have access to all incoming and outgoing emergency lines.

How many telephone lines must each call answerer have access to? In answering this question, be sure to consider both existing lines and any new lines that will be added as a result of implementing 911 service. These lines can include incoming 911 lines, private tie lines, published seven-digit numbers (emergency and administrative), nonpublished seven-digit numbers, and any other lines that might exist or be needed (such as intercom lines).

Do any of the dispatch centers that will receive their calls by the call transfer method over private tie lines also want to have control of any optional features transferred with the call? If so, which features? Not all call answering and transfer equipment can provide this capability.

Which type of dialing is desired: pushbutton or rotary? Some telephone companies offer a choice of pushbutton dialing (called "Touchtone" by the Bell System) or conventional rotary dialing. Pushbutton dialing is faster than rotary dialing but usually is more expensive. If given a choice, the extra cost should be evaluated in relation to the extent of equipment use.

Must the 911 call answerer be able to drop out of a call once it has been transferred without disconnecting the other two parties? Some call transfer equipment arrangements require that the PSAP call answerer remain on the line until the call is completed. This type of operation would prohibit the call answerer from answering another call until the transferred call is completed.

If the 911 call answering function is going to be performed by radio dispatchers (one-stage system) as opposed to having separate call answerers (multi-stage system), will the increase (if any) in the number of lines resulting from implementing 911 service exceed the capacity of the dispatchers' current telephone equipment? If the answer to this question is yes, then the decision will have to be made whether to have two pieces of call answering equipment at each dispatcher position or whether to replace existing equipment with larger-capacity equipment.

After determining answers to the above questions, discussions can be held with the telephone company to determine what equipment it has, or can obtain, that will satisfy the PSAP's requirements. If the telephone company does not have the necessary terminal equipment to meet

these requirements, then a decision must be made to do one of the following: (1) adjust or modify the requirements to match the available telephone company equipment, (2) have the telephone company develop the required equipment, or (3) investigate the feasibility of purchasing the equipment from a non-telephone company source.

When it has been decided which terminal equipment is to be used, add this information to Table B-2 in Appendix B. Some of the items of terminal equipment listed in Table B-2 are for use in a selectively routed system (discussed in Section III-F).

3. Amount of equipment required. The number of pieces of call answering and transfer equipment that will be needed is dependent upon the number of call answering positions that must be manned during the busiest period of the day. There must be at least one piece of equipment for each call answerer on duty during the shift that has the average busiest hour (call answerer staff sizing is discussed in Section II-G-3). In addition, if the PSAP has a supervisory position, it also should be equipped for full 911 call answering and transfer capability.

Each PSAP should have a minimum of two positions equipped for answering and transferring 911 calls. When determining the amount of terminal equipment required, check any applicable mandatory state 911 standards. At least one state has a standard that requires an overflow position to be fully equipped.

If private tie lines have been designed into the system to enable the PSAP to transfer calls, also check to see if the dispatch center or other location to which these lines will go can handle additional lines. If a dispatch center's current call answering equipment does not have the capability to add the required number of additional lines, then it either must install an additional piece of terminal equipment or install new call answering equipment with greater capability.

When the required number of pieces of terminal equipment has been determined, add this information to Table B-2 in Appendix B.

G. Personnel

The next step in designing a 911 system is to determine personnel requirements to staff the Public Safety Answering Point (PSAP). While it is sometimes difficult to determine the number of personnel that will be required, particularly when a large number of agencies are serving a large population, guidelines that will be useful in determining the types and number of required personnel are provided in this section.

1. Types of personnel. The types of personnel required to staff a PSAP are dependent on the size and complexity of its operation. In general, the staff may include 911 call answerers, shift supervisors, a PSAP director, and support staff.

A call answerer's primary duty is to receive telephone requests for emergency service and initiate the proper action necessary to handle the incident or complaint being reported. In smaller (in terms of the volume of incoming calls) systems, the answering of 911 calls probably will be done by the radio dispatcher(s). The methods used to determine the required number of call answerers are discussed in Sections II-G-2 and -3.

When determining call answerer requirements, there may be a need for someone on duty at the PSAP (or quickly accessible by the PSAP) to handle 911 calls made by persons who do not speak English. At least one state has a 911 standard requiring the availability of a bilingual 911 call answerer at all times if more than 5% of the population served by the PSAP speaks a specific primary language other than English. If necessary, this requirement can be satisfied either by having at least one bilingual call answerer on duty, or by designing the telephone system to enable a translator to be conferenced into the 911 call. Remember that although the dispatch center chosen to serve as the PSAP initially might not have this problem, it could occur when the dispatch center starts answering calls from a larger geographical area.

The primary duty of a supervisor is the operational control of all call answerers on duty during the supervisor's shift. Other duties and responsibilities of a supervisor can include: training call answerers; handling special problems as they arise; acting as the interface between call answerers and management; bringing any service, equipment, or personnel problems to the attention of higher management; and acting as a call answerer in the event of an unexpected high volume of calls.

There are no simple guidelines as to when it is necessary to equip and staff a separate supervisor position. This decision must be made on a case-by-case basis while considering the local operational and financial situation. In many PSAPs, supervisory duties are handled either by an existing dispatch supervisor or by a senior call answerer or dispatcher. If it is decided to equip and staff a supervisory position, the following are the total supervisory staff requirements: staffing a supervisory position 24 hours a day, seven days a week will require five persons; staffing two shifts each day will require three people; and staffing one shift each day will require two people.

A PSAP director has the overall responsibility for the operation and maintenance of the PSAP. All supervisors, call answerers, and support staff are under the director's authority. Some of the director's duties and responsibilities include: preparing and administering the

PSAP's annual budget, handling all personnel and staff matters, preparing reports and studies ordered by the management board, and ensuring that the PSAP maintains the required level of service to the community and public agencies.

Usually, the role of PSAP director is filled by an official of the dispatch center where the PSAP is located. There are occasions, however, when it is necessary to hire an individual to serve as the PSAP director. This situation occurs most often when the PSAP is set up to operate as an independent entity.

Some PSAPs require the services of certain support staff such as a secretary and/or a data clerk. The requirement for one or both of these staff positions should be dictated by local needs.

Another important consideration in staff sizing is the potential impact that 911 implementation will have on required staffing levels of dispatch centers that will have their 911 calls transferred to them by the PSAP. If a dispatch center already is heavily loaded prior to 911 implementation and on the verge of adding another call answering and/or dispatch position, consideration should be given to adding the position before 911 is put into operation. This is especially important if a significant increase in call volume with 911 is predicted.

If it is decided that shift supervisors, a PSAP director and/or other non-call answerer staff are required, add this information to Table B-5 in Appendix B.

2. Data needed to compute number of call answerers. To calculate the required number of call answerers to staff each shift, values must be obtained or assumed for the following parameters: ringdown time, average call answerer occupied time, and call volume. Each of these items is discussed below.

a. Ringdown time. Ringdown time is the length of time that a phone rings before it is answered. Several states have 911 standards that require a certain percentage of the calls received in the average busiest hour of each shift to be answered within a specified number of seconds (ringdown time). Usually, the requirement is for 90% of the calls to be answered within 10 s. This design parameter, which also is used to compute the number of telephone lines, was discussed in Section II-E-2-b.

b. Average call answerer occupied time. The average call answerer occupied time is the average time that it takes a call answerer to process an incoming call. This average time is not necessarily the

same as the average call length (discussed in Section II-E-2-c) used to compute the number of telephone lines needed in a 911 system. Average call answerer occupied time is the time taken to handle calls by the direct dispatch method plus the time taken to transfer, relay or refer calls. The example presented in Section II-G-3-a shows how these different periods of time are used to compute call answerer requirements.

c. Call volumes. In computing telephone line requirements, the call volume for the average busiest hour of the week was used. To compute personnel requirements, however, the call volume for the average busiest hour of each PSAP shift is used. The average busiest hour of the week is also the average busiest hour of the shift in which it occurs.

Two approaches to determining the average busiest-hour call volume were discussed in Section II-E-2-d, a detailed method and an approximation method. Whichever of these two approaches is used to determine the overall average busiest hour's call volume also should be used to determine the busy-hour call volumes for the other two shifts in each day.

The detailed method is used as described in Section II-E-2-d except that each dispatch center and other involved emergency service agencies are asked for information describing their busiest hour on each shift. The approximation method, however, must be modified slightly to determine the other two shifts' busy-hour call volumes.

In the approximation method, it was assumed that urban areas would have an average busiest-hour call volume of approximately 0.31 calls for each 1,000 population and rural areas would receive about 0.15 calls per 1,000 population. These two figures are based on the assumption that approximately 10% of the day's total volume of calls occur in the busiest hour (usually on the swing shift). Two different factors must be used for the other two shifts.

Continuing this method, it is assumed that 8% of the day's calls occur on the second busiest shift (usually the day shift), and that 6% of the day's calls occur on the least busiest shift (usually the night shift). These percentages result in urban-area multiplying factors of 0.25 calls per 1,000 population for the day shift and 0.18 calls per 1,000 population for the night shift. The day- and night-shift factors for rural areas are 0.12 and 0.09 respectively. These factors are summarized below.

Area	Swing Shift	Night Shift	Day Shift
Urban	0.31	0.18	0.25
Rural	0.15	0.09	0.12

At this point, the busiest-hour call volumes for the day and night shifts can be determined using the procedure outlined in Section II-E-2-d. Once computed, these new values can be entered in the appropriate columns of Table 2.

3. Procedure for computing number of call answerers. In this section, the method used to determine the number of call answerers needed on each shift and the total call answerer staff requirements are presented.

The emergency call-answering and radio-dispatching functions normally are performed as either a one-stage or a multi-stage (usually two-stage) operation. In a one-stage system, call answering and dispatching both are done by the same individual(s). In a two-stage system, calls normally are answered by one or more individuals and dispatching is done by other individuals. Some dispatch centers use a combination of the two methods.

The implementation of 911 service might require some dispatch centers that currently are operating as one-stage systems to shift to two-stage operation. This is especially true for those dispatch centers that will function as PSAPs. If a dispatcher's workload in a one-stage system reaches the point where the dispatcher must make a conscious decision between answering a call on an emergency line or handling a radio call, then either additional one-stage positions or a shift to a two-stage system is required. If neither of these is done, the level of service provided by the dispatch center that is serving as a PSAP will decrease.

Because of the workload differences between one-stage combined call answering and dispatching, and two-stage separate call answering, the methods for determining the number of 911 call answerers for each case are discussed separately in the following two subsections.

a. Computing the number of call answerers per shift for a two-stage system. Computing the number of call answerers needed for a two-stage system is much easier than for a one-stage system because the call answerers are not partially occupied with dispatching duties.

The number of call answering personnel required to service a given busy-hour call volume is computed using the following Poisson queueing theory equation.*

$$P(>t) = \frac{(\lambda/\mu)^c}{c!(1-\lambda/c\mu)} \cdot \frac{1}{\sum_{n=0}^{n=c-1} \frac{(\lambda/\mu)^n}{n!} + \frac{(\lambda/\mu)^c}{c!(1-\lambda/c\mu)}} \cdot e^{-t(c\mu-\lambda)},$$

where

$P(>t)$ = the probability of having to wait longer than time, t, with all call answerers busy

μ = reciprocal of average effective call answerer occupied time

c = number of call answerers

λ = number of calls in the busy hour divided by 3600, the number of seconds in an hour

t = ringdown time.

Because the above equation is complex and difficult to manipulate using hand-calculation methods, representative values have been computed and entered in Tables A-1, A-2, and A-3 in Appendix A. These tables show the number of call answerers needed for the principal combinations of probability, average effective call answerer occupied time, call volume, and ringdown time. Each of these three tables indicates the number of busy-hour calls that can be handled by from one to thirty call answerers. The average call answerer occupied time in each table varies from 10 s to 120 s in 5 s increments. Only one value for probability (90%) has been used because it is by far the most common and desirable value. In fact, almost all states that have 911 system standards either specify or recommend that 90% of the calls be answered within 10 s. The only difference between Tables A-1, A-2 and A-3 is the ringdown time that is used: Table A-1 uses 10 s, Table A-2 uses 15 s, and Table A-3 uses 20 s.

Table A-1 is used when P(>t) in the Poisson equation equals 0.1 and t equals 10 s. The meaning of these two numbers is that the probability of a caller having to wait longer than 10 s is 0.1 (10%). Another way of saying this is that the longest time that 90% of the callers in the busy hour will have to wait before their calls are answered is 10 s (about two or three rings). During the other hours

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*Saaty, T. L. Elements of Queueing Theory, McGraw-Hill Book Company Inc., New York, 1961. pp. 115-116

of the shift, however, the actual waiting time of at least 90% of the calls would be less than 10 s (assuming constant staffing over the shift). Tables A-2 and A-3 are interpreted in the same manner except that the longest waiting time for 90% of the callers is 15 s and 20 s, respectively.

In order to use the Poisson equation or one of the three tables, the weighted call answerer occupied time and the effective call answerer occupied time must be calculated.

A PSAP receives a mixture of law enforcement, fire protection, and emergency medical calls. Some of these calls are handled completely by the call answerer and some are transferred. Each type of call occupies a call answerer for different lengths of time. Consequently, a modified average call answerer occupied time known as "weighted call answerer occupied time" must be determined. First, the occupied time for each type of call is calculated by multiplying the number of each type of call by the average length of time of that type of call. The weighted call answerer occupied time is this value divided by the total number of calls.

The procedure described in the preceding paragraph is the same as that described and demonstrated in Section II-E-3-b for computing weighted call length. If only a very small percentage of the calls answered by the PSAP are transferred, then the weighted call answerer occupied time is essentially the same as the weighted call length.

Since personnel answering telephone calls do not operate at 100% efficiency (nor are they expected to do so under normal circumstances), a modified weighted call answerer occupied time known as "effective call answerer occupied time" is determined. Effective call answerer occupied time is calculated by dividing the weighted call answerer occupied time by an efficiency factor (in decimal form). Using an efficiency of less than 100% has the effect of increasing the weighted call answerer occupied time.

The calculation of both the weighted and the effective call answerer occupied times are illustrated in the following example. The example also shows how to use Tables A-1, A-2, and A-3.

The basic information in the example presented in Section II-E-3-b (computing the number of incoming 911 lines) will be used in this example of how to determine the number of call answerers that are required on a particular shift. Therefore, for the purpose of this example, the following assumptions can be made:

- The PSAP is receiving calls from only one CO (If more than one CO is involved, then the total number of calls of each type coming in would be considered. Each CO would not be considered individually for the purpose of staff sizing).

- The estimated total number of shift busiest-hour calls that the PSAP will receive is 19.
- 11 of the 19 calls will be handled by the direct dispatch method.
  - 9 of these 11 calls are for a law enforcement agency
  - 1 of these 11 calls is for a fire protection agency
  - 1 of these 11 calls is for an emergency medical agency.
- 5 of the remaining 8 calls will be handled by the call transfer method. (It is not necessary to consider the number of each type of call that is to be transferred, as was the case for telephone line calculations, because the PSAP call answerer's involvement with each transferred call is essentially the same).
- The remaining 3 calls will be handled by the call referral method.
- The average call answerer occupied times are:
  - 60 seconds (s) for law enforcement calls
  - 30 s for fire protection calls
  - 45 s for emergency medical calls
  - 20 s for the call transfer process
  - 15 s for the call referral process.
- Ringdown time is 10 s.
- P(>t) is 0.1. (This means that 90% of the calls will be answered within 10 s).

These assumptions include all of the factors that are needed to use the equation or tables for determining the busy-hour requirement for call answerers, except for the weighted and the effective call answerer occupied times. The following procedure shows how these two times are calculated.

Since call answerers will be handling nine 60-s law enforcement calls, one 30-s fire protection call, one 45-s emergency medical call, five 20-s transferred calls, and three 15-s referred calls, the weighted call answerer occupied time is:

$$\frac{(9 \times 60) + (1 \times 30) + (1 \times 45) \div (5 \times 20) + (3 \times 15)}{19}$$

$$= \frac{540 + 30 \div 45 + 100 + 45}{19} = \frac{760}{19} = 40.00 \text{ s}$$

To compute the effective call answerer occupied time, a reasonable assumption is that the call answerers will be working at an efficiency level of about 85% during normal busy-hour conditions. Therefore, in this example, the effective call answerer occupied time

$$= \frac{40.00}{0.85} = 47.06 \text{ s}$$

Rounding up to the nearest second, the average effective call answerer occupied time is 48 s.

Now, refer to Table A-1 in Appendix A. This table is used to determine the number of required call answerers if 90% of the calls are to be answered within 10 s. As can be seen, there is no column headed 48 s.

When using one of the tables in Appendix A, if the average effective call answerer occupied time that has been calculated falls between two of the columns, then use the column for the smaller occupied time. There are two reasons for doing this rather than using standard numerical roundoff procedures. First, the equation used to develop this table is nonlinear and the call volumes shown in the tables are skewed toward the smaller occupied times. Second, empirical data show that the equation produces a possible overestimate error of from 10 to 20%.*

In this example, then, since the computed value of 48 s falls between the columns headed 45 s and 50 s, the column headed 45 s is used. Therefore, look in Table A-1 in the column headed 45 s to see where a call volume of 19 (the busy-hour call volume in this example) fits. As can be seen, 19 is more than 9 (the maximum number of calls that one call answerer can handle under the assumed design standards), but is less than 47 (the maximum number of calls that two call answerers can handle). Therefore, 19 busy-hour calls with an effective call answerer occupied time per call of 48 s would require two call answerers to be on duty.

This procedure, using the appropriate call volumes, also is used to determine the number of call answerers needed on each of the other two shifts.

b. Computing the number of call answerers per shift for a one-stage system. In a one-stage system, the call answerer (who is also a dispatcher) is occupied partially with performing the dispatching function. Therefore, the procedures for determining the number of busy-hour call answerers outlined in the preceding subsection must be modified in order to compute the staffing requirements for a one-stage system.

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*Based on data collected and analyzed for the New York City 911 System: New York City 911 System Perspective, Final Task Report, SRI Project 7543, August 1980.

The modification requires the planner to: (1) determine the average numbers of each type of dispatcher activity (excluding answering calls on emergency telephone lines) that occurs in the shift busy-hour, (2) determine the average length of time that it takes the dispatcher to perform each type of activity, (3) recalculate the weighted call answerer occupied time to account for dispatching activities, and (4) recalculate the effective call answerer occupied time.

As an example of how to compute the number of call answerer/dispatchers that are required on a particular shift, the example presented in the preceding subsection (II-G-3-a) has been modified. For the purpose of this example, the following additional assumptions are made to account for dispatching activities:

- The estimated total number of busiest-hour dispatch actions is 28:
  - 6 dispatches
  - 18 status checks
  - 4 name and license checks
- The average dispatcher occupied times are:
  - 35 s for a dispatch
  - 10 s for a status check
  - 40 s for a name and license check.

Most dispatchers have more than the three types of activities listed above to be concerned with, but only these three have been used to keep the example simple. When estimating requirements at the local level, all dispatch activities should be considered.

Using the assumptions in the preceding subsection and those listed above, the call answerers/dispatchers will be handling nine 60-s law enforcement 911 calls, one 30-s fire protection 911 call, one 45-s emergency medical 911 call, five 20-s transferred 911 calls, three 15-s referred telephone calls, six 35-s dispatches, eighteen 10-s status checks, and four 40-s name and license checks. Therefore, the weighted call answerer/dispatcher occupied time is:

$$\frac{(9x60) + (1x30) + (1x45) + (5x20) + (3x15) + (6x35) + (18x10) + (4x40)}{47}$$

$$= \frac{540 + 30 + 45 + 100 + 45 + 210 + 180 + 160}{47}$$

$$= \frac{1,310}{47} = 27.87 \text{ s}$$

Assuming a call answerer/dispatcher efficiency level of 85% during normal conditions, the effective call answerer/dispatcher occupied time is:

$$\frac{27.87}{0.85} = 32.79 \text{ s}$$

Rounding up to the nearest whole second, the effective call answerer/dispatcher occupied time is 33 s.

Now, since the assumption is that 90% of the calls will be answered within 10 s, refer to Table A-1 in Appendix A. Since there is no column headed 33 s in this table, use the column headed 30 s for the same reasons stated in the preceding subsection. The busy-hour call volume in this example is 47; therefore, two call answerer/dispatchers, or one call answerer and one dispatcher (if the work load is divided approximately equally) are required.

The same procedure is used to determine the number of call answerer/dispatchers needed on each of the other two shifts.

c. Computing the total number of call answerers required. Once the number of call answerers required for each shift has been determined, it is necessary to compute the total number of call answerers needed to staff the PSAP on a 24-hour, seven-day basis. The information presented in this subsection is meant to provide general guidance in estimating these total staff requirements. Local agencies' experience in staffing dispatch operations can provide a more accurate estimate of the size of the total staff.

The total number of 911 call answerers needed to staff a PSAP 24-hours a day, seven days a week, depends on the number and distribution of calls throughout the entire day. The total call answering staff must be large enough to allow the staff to work 40 hours a week and have time off from work for vacations, sick leave, and holidays.

Empirical data shows that total staff requirements can be estimated roughly be multiplying the sum of the call answerers on all shifts by a factor of 1.6. This factor normally varies between 1.5 and 1.7 depending on local conditions, but 1.6 usually will give an adequate estimate for 911 system-design use. If a more accurate estimate is needed, then the following equation can be used to obtain the adjustment factor:

$$\text{Adjustment factor} = \frac{\frac{A \times B}{C \times D}}{E} = \frac{A \times B}{C \times D \times E}$$

where

A = number of days in a year = 365

B = number of hours in a day = 24

C = number of hours a call answerer is supposed to work per week
= (number of hours in a shift) × (number of shifts worked per week)

D = number of weeks worked per year
$= \frac{365 - \text{vacation days} - \text{sick days} - \text{holidays}}{7}$

E = number of shifts that must be staffed each day

Since A and B are known, the above equation can be simplified as follows:

$$\text{Adjustment factor} = \frac{365 \times 24}{C \times D \times E} = \frac{8{,}760}{C \times D \times E}$$

The following example illustrates how to compute the adjustment factor. For the purpose of this example, the following assumptions are being made:

- Each shift is 8 hours long
- A call answerer works 5 shifts each week
  (Therefore, C = 8 x 5 = 40)
- Call answerers receive 10 days vacation per year
- Call answerers take an average of 11 days of sick leave per year
- Call answerers receive 9 holidays per year
  (Therefore, $D = \frac{365 - 10 - 11 - 9}{7} = \frac{335}{7} = 47.8$)
- 3 eight-hour shifts must be staffed each day
  (Therefore, E = 3).

Therefore, in this example, the adjustment factor is:

$$\frac{8{,}760}{40 \times 47.8 \times 3} = \frac{8{,}760}{5{,}736} = 1.53$$

Now, as an example of computing the total staff required, assume that one shift has two call answerers on duty and that each of the other two shifts requires only one call answerer to be on duty. The sum of all three shifts for one day is four call answerers. Therefore, the total staff required is:

(Total number on duty during day) × (adjustment factor)
= 4 x 1.53 = 6.12

Therefore, the total staff should be six call answerers.

As another example, assume that two shifts have two call answerers on duty and one shift has only one call answerer on duty. This is a total of five call answerers to staff the PSAP for one day. Multiplying 5 by 1.53 equals 7.6. Therefore, the requirement is for a total of 7.6 answerers on the staff.

There are three basic alternative staffing solutions: (1) have only seven persons on the staff and require the call answerers to work overtime occasionally, (2) have seven full-time call answerers and one part-time person on the staff, and (3) have eight call answerers on the staff.

When the total number of call answerers or call answerer/dispatchers has been computed, add this information to Table B-5 in Appendix B.

H. Other Equipment Considerations

This section of the manual addresses several items of equipment that, while they are not always essential to a PSAP's operation, may enhance the operation of a PSAP. Several of these items are considered mandatory 911 standards by some states.

1. Master audio logging recorder. The date and time of each 911 call and the method of handling at the PSAP should be documented. Several states have mandatory 911 standards requiring that this be done. This documentation provides an official record that can be used either in the event of litigation or if a dispute arises between the PSAP and one of the emergency service agencies for which it answers 911 calls. This documentation can be accomplished in one of two ways: the 911 call answerers can log in all 911 calls manually, or calls can be recorded automatically by audio tape recording equipment.

For the call answerers to log all calls manually increases their effective occupied time per call and increases the amount of paperwork to be handled. Audio recording is not only a faster and more accurate method, but also might be the least expensive of the two logging methods due to decreased personnel costs. Clearly, increasing the call answerers' occupied time per call could cause an increase in the number of call answerers required.

The audio recording procedure can be accomplished in one of two ways. In the first way, each 911 call answering position at the PSAP can be tied into its own individual channel on a master logging recorder

that then records the PSAP's participation in all 911 calls. Then, if a caller is transferred, the dispatch center receiving the transferred call records the remainder of the conversation on its master logging recorder. In the second way, each incoming 911 line is terminated on its own channel on a master logging recorder at the PSAP so that the entire call is recorded at the PSAP.

If it is decided to include an audio tape recording method in the 911 system, the first step is to determine how much (if any) unused recorder capacity exists at those dispatch centers that will have their 911 calls transferred to them by the PSAP. Then a simple analysis will be needed to determine how many recorders are necessary for each of the two ways and; therefore, which of the two recording procedures is the least expensive. The least expensive recording alternative, (involving the fewest recorders) especially when the PSAP is transferring calls to a large number of dispatch centers, usually is to record each 911 line on its own channel on a master logging recorder at the PSAP.

If it is decided to use the audio tape-recording method, enter the appropriate information in Table B-6 in Appendix B.

2. Individual answering-position audio recorders. At least one state has a requirement that each 911 call answering position at the PSAP (including the supervisory position if there is one) be equipped with an instant-playback-type recorder to record each incoming 911 call handled by each position. This type of recorder automatically records both parties in an emergency call and provides the call answerer with an immediately accessible transcript (without interrupting the master logging recorder) if information must be repeated or reconfirmed but the caller is no longer available.

If it is decided to use individual answering-position audio recorders, enter the appropriate information in Table B-6 in Appendix B.

3. Telephone call counters. Consideration should be given to installing digital call counters (registers) on the incoming 911 lines at the PSAP. These counters are available from the telephone company and can provide data that describe the call volume being handled by the PSAP. The information obtained by reading and recording call counters at specified intervals not only will be helpful in preparing periodic operational reports but also will enable workload trends and, consequently, required staffing levels, to be determined more easily.

If it is decided to use call counters, enter the number that are required in Table B-4 in Appendix B.

4. Intercom system. Large PSAPs should consider installing an intercom system to enable call answerers, radio dispatchers, and shift supervisors to speak to one another without leaving their work stations or yelling across the room. The following are several potential benefits that can be derived by using such a system: (1) a call answerer can alert the proper dispatcher quickly when a "hot" call comes in so the dispatcher can listen in and make an immediate dispatch if required, (2) call answerers or dispatchers can ask each other or their supervisor for assistance, and (3) everyone on duty at the PSAP can be alerted when a major incident is taking place.

If it is decided to implement an intercom system, add the appropriate information to Table B-6 in Appendix B.

5. Recorded announcement equipment. A recorded announcement capability is available from most telephone companies and should be considered by those PSAPs that serve large, high-population metropolitan areas. If a caller receives a busy signal because all call answerers are occupied (which can occur during a major disturbance or incident such as a highly visible fire or a sonic boom), the caller will hear a recorded message stating that all call answerers are busy (or any other pre-programmed message that may be desired). The recorder should be located at the PSAP so that the PSAP has complete control over the contents of the recorded message.

A call counter also can be connected to the recording system to count the number of times that the delayed announcement is automatically activated. This data will aid in ensuring that proper staffing levels are maintained.

At least one state has a mandatory 911 standard that requires the PSAP to have a recorded announcement capability when the terminal equipment being used is an automatic call distributor (ACD).

If it is decided to implement recorded announcement equipment, enter the appropriate information to Table B-4 in Appendix B.

6. Standby emergency power. Continuous operation of 911 telephone equipment usually depends on a local source of commercial power. Interruption of that power in most cases will halt operations. Therefore, several states have mandatory 911 standards that require the PSAP to be equipped with an emergency power source capable of supplying electricity to serve at least basic PSAP power requirements in case of commercial power failure.

At least one state also requires that an adequate uninterruptable power source be installed if sophisticated telephone equipment (such as the 8A Key System, which will not tolerate power fluctuations or interruptions) has been implemented.

If it is decided to implement a standby emergency power source or an uninterruptable power source, enter the appropriate information in Tables B-6 and B-4, respectively, in Appendix B.

7. Incident location/agency cross index. If the PSAP will be answering 911 calls for a large number of emergency service agencies, then certain materials and techniques probably will have to be developed to enable call answerers to determine accurately and rapidly which agency should respond to each 911 call. One or a combination of the following methods, depending on local requirements and existing resources, can be implemented: (1) a map showing the jurisdictional boundaries of all agencies for which the PSAP is answering 911 calls; (2) a computerized geocoding file containing a telephone number, street address, serving agency cross index; (3) a cardex manual geocoding file; or (4) a geocoding file on microfiche.

Some sort of incident location/agency cross index should be developed. Even if selectively routed 911 service is implemented, the cross index should be available in case the default routing feature (discussed in Section III-D-1-d) is activated for any calls.

If it is decided to implement some sort of incident location/agency cross-index system, enter the appropriate information in Table B-6 in Appendix B.

CHAPTER III. DESIGNING A SELECTIVELY ROUTED 911 SERVICE SYSTEM

A. General

The procedure for designing a system to provide selectively routed (SR) 911 service now will be discussed. Before reading this chapter, however, the preceding chapter on designing a basic 911 service system should be read. Rather than repeating most of the information presented in Chapter II, frequent references will be made to sections of that chapter.

As can be seen by the size of the preceding chapter, the emphasis of this manual appears to be on the design of basic 911 service systems rather than on the design of SR 911 service systems. There are two principal reasons for this emphasis. First, only four of the at least 807 systems operating at the time this manual was written were totally SR. This means that a far greater number of local governments probably will be interested in basic 911 service than in SR 911 service. Secondly, most of the contents of Chapter II also apply to Chapter III as well. In fact, everything said about designing a basic 911 service system also applies to designing an SR 911 service system unless stated otherwise in this chapter.

The remainder of this section is comprised of a list of action items that together provide a summary of the selectively routed 911 service system design process discussed in this manual. These items are presented in the same order in which they are discussed in this manual. The section of the manual in which each item is addressed is noted in parentheses following each item.

Following is the list of items:

System Boundaries and Configuration

1. Decide which local law enforcement jurisdictions will be served by the 911 system. (III-B)
2. Select PSAPs on the basis of local law enforcment dispatch centers. (III-B)
3. Obtain copies of maps showing the service area boundaries and dispatch center locations of the local public safety agencies. (III-B)
4. Copy agency boundaries and dispatch center locations onto a common map. (III-B)

System Boundaries and Configuration Continued

5. Obtain telephone company Exchange Area Boundary Maps. (III-B)
6. Copy telephone central office service area boundaries onto the same common map that has the agency boundaries. (III-B)
7. Make a list of all emergency service agencies--local, state and federal--whose emergency calls might be answered by each PSAP. (III-B)
8. Develop a table of infomation that lists: (1) the emergency service agencies that will be served by each PSAP, and (2) the name of the dispatch center serving each agency. (III-B)

System Operation

9. Select the method that will be used to route 911 calls, or the appropriate information, from each PSAP to each emergency service agency. (III-C).

Telephone Service Features

10. Select the telephone service features to be implemented. In particular, for each dispatch center that will have its calls transferred to it from a PSAP, decide whether the manual, fixed, or selective transfer method will be used. (III-D)

Telephone Lines

11. Decide which dispatch centers or other locations, if any, will be connected to the PSAP by private tie line. (III-E-1)
12. Decide for what purposes nonpublished seven-digit-number lines will be used by each PSAP. (III-E-1)
13. Select a grade of service to be used in computing the number of telephone lines that are required. (III-E-2)
14. Select a ringdown time to be used in computing the number of telephone lines that are required. (III-E-2)
15. Determine the average call lengths of emergency calls made to law enforcement, fire protection, and emergency medical service (EMS) agencies. (III-E-2)
16. For design purposes, select an amount of time for the call transfer process. (III-E-2)
17. Determine the average busiest-hour call volume for each dispatch center and agency involved. (III-E-2)
18. Determine the overall average busiest-hour call volume for each PSAP. (III-E-2)
19. Estimate how many of each PSAP's busiest-hour calls will be for each agency it serves, and add this information to the table that was developed. (III-E-2)

Telephone Lines Continued

20. Compute the number of incoming 911 lines required. (III-E-3)
21. Compute the number of control office transfer lines required. (III-E-3)
22. Compute the number of nonpublished seven-digit-number lines required. (III-E-3)
23. Decide whether the PSAP's administrative phone number will be an existing published number or a new number. (III-E-3)

Call Answering and Transfer Equipment

24. Summarize terminal equipment requirements. (III-F-2)
25. Select the type of terminal equipment to be used. (III-F-2)
26. Determine the number of pieces of terminal equipment required. (III-F-3)

Personnel

27. Decide if a supervisory position, in addition to the regular 911 call answering positions, is to be implemented. (III-G-1)
28. Determine how many persons will be needed to staff the supervisory position if it is decided to have one. (III-G-1)
29. Decide if each PSAP director will be an employee of a local agency or someone hired specifically for the job. (III-G-1)
30. Decide if the services of a secretary or a data clerk are required. (III-G-1)
31. Select a ringdown time to be used in computing the number of call answerers. Use the same ringdown time that was used to compute the number of telephone lines. (III-G-2)
32. Determine the average call answerer occupied time per call. (III-G-2)
33. Determine the busiest-hour call volumes for each dispatch center and each other involved agency for the other two shifts at each PSAP. (III-G-2)
34. Determine the overall busy-hour call volumes for the other two shifts at each PSAP. (III-G-2)
35. Add the other two shifts' busy-hour call volume information to the table that was developed. (III-G-2)
36. Compute the number of call answerers that are required to man each shift. (III-G-3)
37. Compute the total number of call answerers required. (III-G-3)

Other Equipment Considerations

38. Decide which method the PSAP will use to document the 911 calls it receives. (III-H)

39. If it is decided to use the audio tape recording method to document 911 calls, determine: (1) which recording procedure will be used, (2) how many tape recorders of what size will be needed, (3) if the proper playback equipment is available or if it must be purchased, and (4) the quantity of audio recording tape that will be needed. (III-H)

40. Decide if individual answering position audio recorders are to be implemented. (III-H)

41. Determine how many individual answering-position audio recorders will be required. (III-H)

42. Decide if call counters are to be used. (III-H)

43. Determine how many call counters will be required. (III-H)

44. Decide if an intercom system is to be used. (III-H)

45. Decide if recorded announcement equipment is to be used. (III-H)

46. Decide if a standby emergency power source is to be used. (III-H)

47. Decide if an uninterruptable power source is required. (III-H)

48. Decide if some sort of incident location/agency cross index must be developed. (III-H)

B. System Boundaries and Configuration

A basic 911 service system has only one PSAP. An SR 911 service system, on the other hand, has more than one PSAP. However, since selective routing automatically routes each 911 call to a predetermined answering point based on the location of the calling telephone, choosing the PSAP locations and defining the 911 system boundary is very simple for an SR system.

Each local law enforcement dispatch center in the area for which the 911 system is to be designed normally will serve as a PSAP. Therefore, the boundary of the area served by each PSAP would be simply the boundary of the area(s) served by the law enforcement agency(ies) being dispatched from the PSAP location. This means that if a particular dispatch center is answering emergency calls and dispatching for more than one local law enforcement agency, then that dispatch center would act as the PSAP for all of the agencies being dispatched by it. This is true even if their various jurisdictions are not adjacent to each other or if they are in different telephone company central office (CO) service areas. The overall boundary of the 911 system is defined by the outside boundary made by the group of CO areas that have been selectively routed.

Even though selective routing eliminates the boundary mismatch problem between local law enforcement agencies, there is still a potential mismatch of fire protection and emergency medical service (EMS) areas with the law enforcement boundaries. Some cities are served by more than one fire protection and/or EMS agency. This is especially true for the unincorporated areas of most counties which usually have several fire protection and EMS agencies in an area served by one law enforcement agency. Similarly, the service areas of some fire and EMS agencies frequently overlap the areas covered by more than one local law enforcement agency.

Because of the law enforcement/fire/EMS service area mismatch situation, and even though it is simpler to choose PSAP locations and define the system boundary, the design of an SR system begins the same way as for a basic system design. Copies of the telephone company CO and public safety agency service area boundary maps must be obtained and copied onto a common map.

The principal reasons for developing the common map in the case of an SR system are so that it can be seen clearly which fire and EMS agencies will have some or all of their 911 calls answered by each PSAP, and where the fire and EMS dispatch centers are located. Also, since each CO area must be completely selectively routed, the common map will help ensure that no local agencies are overlooked.

The sample table of information described by Table 1 (and the procedures discussed in Chapter II for its use) are not needed now because the boundary mismatch between the telephone company CO boundaries and the public safety agency service area boundaries are of little concern in an SR system. The PSAP locations and their coverage areas are independent of the CO boundaries and already have been determined on the basis of law enforcement dispatch center service boundaries. The second type of table (similar to Table 2 which was developed in Chapter II) will be needed, however. In filling out this table, be sure to include (in addition to the local law enforcement, fire protection and EMS agencies) any local units of the state police/patrol, state forestry and federal fire protection; as well as poison control, suicide prevention, crisis centers, university or college emergency services (if they do not have their own PSAP); U. S. Coast Guard facilities, and any other applicable emergency services.

Enter the names of the COs from which the PSAP will receive calls in the appropriate location in Table B-1 in Appendix B.

C. System Operation

The introductory comments to this section are the same as those in Section II-C.

1. 911 operational methods. Descriptions of the four basic 911 call handling methods--direct dispatch, call transfer, call relay, and call referral--are provided in Section II-C-1.

2. Selection of a call handling method. The comments made in Section II-C-2 regarding the selection of a call handling method are essentially the same for this subsection. However, three methods of transferring calls usually are available with selective routing instead of the two methods available to a basic system. These three methods--manual transfer, fixed transfer, and selective transfer--are explained in Section III-D.

D. Telephone Service Features

The selectively routed 911 service offered by the Bell System includes several standard features and a number of optional features. These features are discussed in Sections III-D-1 and 2. Features that might be offered by independent telephone companies were unknown at the time this manual was written.

Three optional features--called party hold, ringback, and switchhook status indication--discussed in Section II-D-1, are not available in an SR 911 system.

1. Description of standard features. The seven features discussed below normally are offered with SR 911 service at no additional charge.

a. Manual transfer. Manual (dial) transfer is one method that can be used to transfer calls in an SR system. The manual transfer feature enables the 911 call answerer to transfer a call by pressing a button on the 911 Display and Transfer Unit (discussed in Section III-F-1) and dialing either a seven-digit or ten-digit telephone number or a two-digit Speed Calling code using associated terminal equipment.

The telephone number of the calling telephone cannot be transferred with the call when the manual transfer method is used even if automatic number identification (ANI) has been implemented in the system.

b. Fixed transfer. Another method of transferring 911 calls in an SR system is called the fixed transfer feature. The fixed transfer feature enables the 911 call answerer to transfer 911 calls to preselected locations by use of a single button on the 911 Display and Transfer Unit. Each of the several available buttons is associated with a specific answering point. ANI cannot be transferred with the call when the fixed transfer method is used unless the transfer is made onto a dedicated line and the receiving location is equipped to accept and display the ANI information.

c. Selective transfer. The selective transfer feature is the most advanced transfer method available for use in an SR 911 system. This feature provides the call answerer with the ability to transfer an incoming 911 call to another agency by depressing a single button labelled with the type of agency (rather than name, as in the fixed transfer feature), e.g., "Fire" or "EMS," on the 911 Display and Transfer Unit. ANI also is transferred with the call if ANI has been implemented and if the receiving location is equipped to accept and display the ANI information.

The selective transfer feature is valuable when the area served by a PSAP includes more than one fire or EMS dispatch center, because the call answerer does not have to determine which agency (if there are two or more choices) should receive the call. The answerer simply pushes a single button and the system, based on the location of the calling telephone, automatically forwards the call to the correct dispatch center.

d. Default routing. This feature is activated when an incoming 911 call cannot be selectively routed due to an ANI failure; garbled digits; when a call originates from a foreign exchange station (calling telephone is located outside the 911 system's service area but is served by a central office that is selectively routed); when a call originates from a four-party, eight-party, or farmer-line station; or when other causes prevent selective routing. Such incoming calls are routed by the control office (telephone company CO which controls the selective routing of 911 calls) to a preselected default PSAP (the PSAP which normally receives most of the 911 calls from the end office involved).

Each incoming 911 line to the control office is assigned a designated default PSAP which may or may not be the same as the normal PSAP. ANI normally is forwarded with a default routed 911 call, but the ANI display flashes to indicate that the call was default routed and that the number displayed might be in error.

e. Alternate routing. This feature automatically routes 911 calls to a designated alternate location if all incoming 911 lines to a PSAP are busy, or if the PSAP closes down for a period (night service).

f. Forced disconnect. The forced disconnect feature is described in Section II-D-1-b.

g. Idle circuit tone application. The idle circuit tone application feature is described in Section II-D-1-d.

2. Description of optional features. The features described below are offered normally for an additional charge with SR 911 service.

a. Automatic number identification. ANI is described in Section II-D-1-f. The incremental cost of implementing ANI with selective routing is much less than the cost of implementing ANI with a basic system.

b. Automatic location identification. ALI is described in Section II-D-1-g. The incremental cost of implementing ALI with selective routing and ANI is much less than the cost of implementing ALI with a basic system and ANI.

c. Dial tone first. Dial tone first (DTF) is described in Section II-D-1-h.

3. Selection of optional features. The decision as to which optional features to consider implementing usually is made by a consensus of emergency service agencies that will be served by the system. When making this decision, two things should be considered: the impact on the overall operation of the 911 system by the PSAP, and the impact on certain dispatch centers that receive their 911 calls from the PSAP by the call transfer method.

The final selection of optional features can be decided by looking at alternatives and evaluating them in a cost-effectiveness analysis (discussed in Section V-C).

Indicate in Table B-3 of Appendix B those telephone service features that have been designed into the 911 system.

E. Telephone Lines

1. Types of lines and their uses. The descriptions given in Section II-E-1 of the various types of lines and their uses also apply to SR systems, with the following modifications: the incoming 911 lines must be direct trunked in an SR system. Also, the outgoing private tie lines do not run from the PSAP to the dispatch centers receiving transferred calls as they do in a basic system. These lines run from the control office to the dispatch centers. This type of transfer arrangement frees the incoming 911 line to the PSAP after the transfer has been completed, which is not the case in a basic 911 service system. Standard private tie lines still can be implemented, however, if a PSAP has a particular operational situtation which requires their use.

When it has been decided which dispatch centers will be connected to the control office by transfer lines, add the names of these dispatch centers to Table B-1 in Appendix B.

In addition, as pointed out in Section III-D, each PSAP will have the manual (dial) transfer feature available to transfer 911 calls to seldom-contacted agencies (and for backup) using the public switched telephone network, and a choice between the fixed and selective transfer features to transfer 911 calls to the principal dispatch centers.

2. Data needed to compute number of lines. The discussion in Section II-E-2 regarding the data needed to calculate the number of required telephone lines also applies to SR systems, with the following modifications: the busy-hour call volume information will be easier to estimate for an SR system since only one local law enforcement dispatch center will be involved with each PSAP, and because determining the call volume breakdown by CO is not required.

When the call volume for the busiest hour of each shift has been estimated (by the procedure explained in Section II-E-2-d) for each agency being served by the PSAP, enter this information in the last three columns of the table similar to Table 2. As pointed out in Section III-B, a table similar to Table 1 is not necessary in designing a SR system.

3. Procedure for computing number of lines. The procedure for computing the required number of each type of telephone line is discussed in Section II-E-3 and is the same for an SR system with one modification: the telephone company will determine the required number of lines to connect each CO with the control office.

When the required number of incoming 911 lines, control office transfer lines and published and nonpublished seven-digit-number lines have been determined, add this information to Table B-1 in Appendix B.

F. Call Answering and Transfer Equipment

The introductory comments to this section are the same as those made to introduce Section II-F.

1. Types of terminal equipment. There is not a wide choice of call answering and transfer equipment for SR 911 service, as compared with basic 911 service, because of the advanced nature of selective routing and its various features. The principal types of equipment that Bell System-provided selective routing is designed to be compatible with are conventional key systems (multibutton key sets or call directors) and the Type 2B Automatic Call Distributor.

Generally speaking, PBX equipment is not compatible with SR 911 service requirements. If a PSAP already has a PBX in operation, it might be necessary to install conventional key-system-type equipment to augment the PBX.

If the SR system is to have the fixed and/or selective transfer features (discussed in Sections III-D-1-b and c), then each principal 911 call answering position at each PSAP and at each main dispatch center receiving transferred calls will have to be equipped with a 911 Display and Transfer Unit. This unit contains the ANI display and is also the call transfer and conferencing control unit. This unit is also necessary if ANI is implemented with a basic system.

Each PSAP and major secondary answering point also will have to be equipped with a microprocessor-controlled, stored-program ANI master controller. This piece of equipment controls the display of ANI at the answering positions, relays call transfer directions back to the control office, and provides output to the logging teletypewriter (TTY) if one has been installed.

As indicated above, the option exists to install a receive-only TTY at each PSAP and at each other principal dispatch center. The purpose of the TTY is to print out automatically specific information regarding each 911 call that is handled. This information can include the following: (1) the ANI number, (2) a code indicating which call answering position handled the call, (3) the time of day that the 911 line was seized by the incoming call, (4) the time of day that the call first was answered, (5) the time of day that the call was transferred last (if it was transferred), (6) the time of day that the call was disconnected, and (7) the code number of the specific 911 line that was used. Each time of day is printed out to the nearest second.

If ALI is implemented, then special equipment, including an ALI master controller, which retrieves and displays address location information also will be required. One of these displays would be needed at each call answering position that is equipped with an ANI display.

As pointed out in this manual, no independent telephone company, at the time this manual was written, had implemented a complete selectively routed 911 system, nor had they implemented ANI or ALI. Therefore, all equipment referred to in this subsection is Bell System-supplied equipment.

2. Selection of terminal equipment. The requirements for the call answering and transfer equipment should be summarized before attempting to select the appropriate equipment. Answers to the questions in the following six paragraphs will define the basic requirements.

Is the fixed transfer and/or selective transfer feature desired? If the answer to this question is yes, then 911 Display and Transfer Units are required.

Is the ANI feature desired? If the answer is yes, then 911 Display and Transfer Units are required.

Is the ALI feature desired? If the answer is yes, then ANI, 911 Display and Transfer Units, and ALI display equipment are required.

Is detailed timing information and other data regarding the handling of 911 calls desired? If the answer is yes, then a receive-only TTY is required.

Is non-key-system-type terminal equipment currently in use at the answering points? If the answer is yes, then additional or new terminating station equipment may have to be installed.

The questions and comments in Section II-F-2 regarding the requirements for call answerer access to all telephone lines, the number of lines that each call answerer must have access to, pushbutton versus rotary dialing, and the capacity of current pre-911 call answering equipment also apply to the terminal equipment used in a SR system.

The last paragraph in Section II-F-2 regarding discussions with the telephone company also applies in the case of SR system design.

When it has been decided which terminal equipment is to be used, add this information to Table B-2 in Appendix B.

3. Amount of equipment required. The comments made in Section II-F-3 essentially apply to this subsection with one additional comment: each answering point that requires the full capability of the system must have master control equipment. Some large PSAPs might even require auxiliary controllers.

When the required number of pieces of terminal equipment has been determined, add this information to Table B-2 in Appendix B.

G. Personnel

1. Types of personnel. The discussion in Section II-G-1 regarding the different categories of personnel that may be required to staff a PSAP also applies to SR systems. If it is decided that shift supervisors, a PSAP director and/or other non-call answerer staff are required, add this information to Table B-5 in Appendix B.

2. Data needed to compute number of call answerers. The discussion in Section II-G-2 regarding information that is necessary to calculate the number of call answerers for each shift also applies to SR systems.

3. Procedure for computing number of call answerers. The methods presented in Section II-G-3 for determining shift- and total-staff call answerer requirements also apply to SR systems. When the total number of call answerers or call answerer/dispatchers has been computed, add this information to Table B-5 in Appendix B.

H. Other Equipment Considerations

The discussions in Section II-H regarding seven other types of equipment also apply to SR systems. If it is decided to implement any other items of equipment, enter the appropriate information in Table B-4 or Table B-6, depending on the piece of equipment in question.

I. Selective Routing Using Class-of-Service Marks

Up to this point, Chapter III has dealt with full computer-controlled selective routing using the telephone number and address of the calling telephone as the routing criteria. There is one other method of selective routing that has been used to partially selectively route two small 911 systems. This method uses class-of-service marks (or class marks) to accomplish the selective routing.

The purpose of class-of-service marks is to identify separately groups of telephone customer lines which require different call treatment either for routing or for billing.

Using class-of-service marks for the purpose of selective routing can be costly. The cost for applying this method to non-common-control central office switching equipment, such as step-by-step or XY (which has not been done yet), might be prohibitively expensive because of the office reconfiguration requirements. Applying this method to common-control switching equipment is less difficult, especially for electronic equipment, but is still potentially expensive. This method is also subject to a higher error rate than the full computer-controlled method.

At the time this manual was written, only two independent telephone companies had implemented class-of-service marks selective routing for parts (three common-control offices) of two 911 systems, each servicing two PSAPs. No Bell System company has implemented this type of selective routing yet.

If this type of system is of interest, discussions should be held with the serving telephone company to determine if it is able and willing to provide the service, and what the estimated initial and recurring costs will be.

CHAPTER IV. ESTIMATING THE COST OF A 911 SYSTEM

Once an alternative 911 system has been designed using the procedures presented in either Chapter II or Chapter III, obtaining a cost estimate for the system will be relatively simple. The procedures for obtaining estimates of the initial (one time) and recurring (monthly) costs (costs to the local governments involved) of both basic and selectively routed 911 service systems are presented in this chapter.

To ensure a fair and meaningful comparison of 911 system alternatives, only those costs that will be incurred as a result of the implementation and operation of 911 service should be considered. Existing (pre-911) costs should not be included.

In this chapter, the potential costs associated with the implementation and operation of 911 service are divided into the following principal categories: (1) Telephone System Costs, (2) Personnel Costs, (3) Other Equipment Costs and (4) Ancillary Expenses. Each of these major categories is further subdivided into its component elements.

An overall summary of the inputs to and outputs from the 911 system costing process are shown in Figure 4.

A. Telephone System Costs

There are no simple formulas for estimating the costs of the various elements of the telephone system and, for reasons that are beyond the scope of this manual to explain, it is not practical to develop these formulas or a cost model. Planners who are interested in learning more about the variations and complexities of 911 service-related telephone tariffs are referred to the following report: An Analysis of 911 Emergency Telephone Service and Tariffs, Transcom, Inc., Falls Church, Virginia, U.S. Department of Commerce, 28 February 1980.

The fastest, most straightforward method of obtaining estimates of the telephone system costs is to provide the telephone company with a list of the types and quantity of telephone system elements that are required (or desired), and request the telephone company to provide the cost estimates. This list--contained in Tables B-1, B-2, B-3 and B-4 in Appendix B-- was developed during the system-design process.

Table B-1 is a worksheet for noting telephone line requirements and costs. The different types of telephone lines and the procedures for determining the number required were discussed in Sections II-E

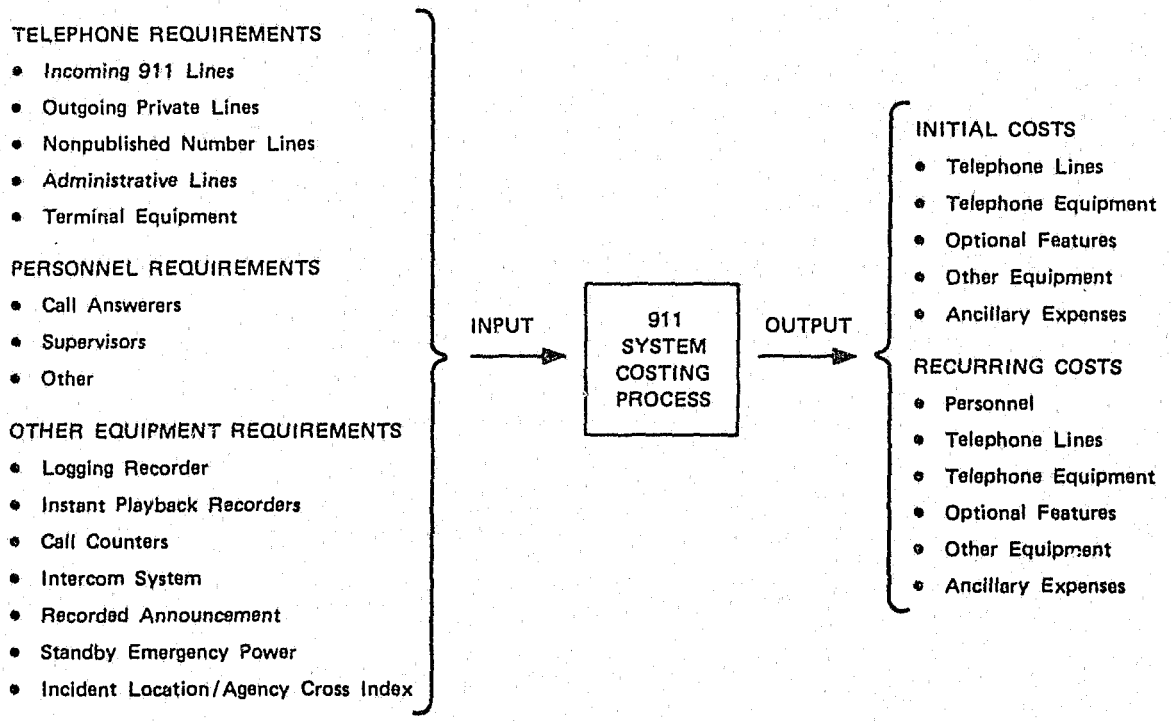


FIGURE 4 SUMMARY OF 911 SYSTEM COSTING INPUT AND OUTPUT ELEMENTS

and III-E. If there are more COs or dispatch centers than there is room to indicate in this table, an additional sheet should be used.

Table B-2 is a worksheet for noting call answering and transfer equipment requirements and costs. The basic types of terminal equipment and the process for selecting the most appropriate type were discussed in Sections II-F and III-F.

Table B-3 serves as a checklist to indicate which telephone service features (standard and optional) are to be priced into the system. The telephone service features were discussed in Sections II-D and III-D. Some telephone companies do not price some of the service features as separate items but include them as part of the cost of other elements, such as the incoming 911 lines.

Table B-4 is a worksheet to note any other telephone system-related elements and their costs not included in Tables B-1, B-2, and B-3. The elements shown in Table B-4 were discussed in Sections II-H and III-H. Be sure to include in this table any 911 implementation and operation costs (except those in Tables B-1 and B-2) incurred by the dispatch centers being served by the PSAP.

Since the purpose of these worksheets is to serve as the basis for detailed discussions with the telephone company regarding requirements and how they can be satisfied, only the most basic elements have been included.

Blank element spaces have been included in Tables B-1, B-2, B-3, and B-4 for several reasons. One reason is to enable additional elements to be added if necessary. Another reason is to provide space so that the telephone company can list certain of the component items, (and their costs) which contribute to the cost of a given basic element. Also, there are sometimes miscellaneous (but not necessarily inexpensive) costs associated with the implementation of a telephone system that should be listed by the telephone company.

When requesting cost estimates from the telephone company there are two important things to remember. First, ask if there are alternative ways to satisfy any of the requirements listed in the worksheets; if there are, ask for cost estimates for these alternatives. Secondly, some telephone companies offer some services and terminal equipment on a contract basis (as opposed to the basic rate plan) with the initial and monthly costs varying in relation to the type and length of the contract. Therefore, the system planner should ask the telephone company if this situation exists and, if it does, obtain the information necessary to decide which pricing concept best meets the needs of the local governments involved.

B. Personnel Costs

Table B-5 in Appendix B is a worksheet for noting personnel requirements. System-design requirements for personnel were discussed in Sections II-G and III-G.

The estimated monthly personnel cost will have to be determined by a local planner because local salary levels vary considerably around the country and sometimes within a given county. There are two basic methods for determining a salary for call answerers and/or dispatchers for cost estimating purposes: use of the salary structure of the dispatch center where the PSAP will be located, or use of the average salary paid by all of the dispatch centers that will be served by the PSAP.

To be accurate, the salaries chosen for planning purposes should be increased by some percentage to cover employer-supplied fringe benefits such as vacation, sick leave, Social Security, retirement, insurance, etc. If the actual dollar amount of fringe benefits is unknown, 25% of salary is a reasonable figure to use for planning purposes.

As an example, if a call answerer's salary of $800 per month plus 25% for fringe benefits was used for planning purposes, the cost of one call answerer as entered in Table B-5 would be $1,000 per month.

C. Other Equipment Costs

Table B-6 in Appendix B is a worksheet for noting any non-telephone system equipment that might be required. The elements shown in this table were discussed in Sections II-H and III-H.

There is a considerable variation in the capacity, quality, and cost of the various pieces of equipment that are available to satisfy the requirements listed in Table B-6. Therefore, the estimated costs of these elements should be obtained from vendors of the equipment in question.

The pieces of equipment listed in this table have monthly costs in the form of maintenance--preventive and corrective. Local agencies' experience with any of this equipment is the best source of maintenance-cost information. If there is no maintenance-cost data available, then a reasonable estimate for planning purposes is that the monthly maintenance cost will be approximately 0.5% of the purchase price.

D. Ancillary Expenses

Table B-7 in Appendix B is a worksheet for noting any 911 system-related expenses that are not covered by Tables B-1 through B-6.

Costs for these elements will have to be determined locally by the system planner.

The fifth element in Table B-7 is necessary when selective routing is to be implemented. In developing the selective routing data files, each unique combination of local law enforcement, fire protection and emergency medical dispatch areas must be identified and assigned a code number known as an Emergency Service Number (ESN). This must be done on a building-by-building, street-by-street basis using a combination of the appropriate local government records and telephone company information.

The amount of local government-furnished man-hours required to develop the ESN list will vary depending on the number of buildings and streets involved, the degree of the various jurisdictional and telephone boundary mismatches, and the availability of adequate local government records. This process could take as much as one man-year of labor. The telephone company may be able to provide some assistance to the planner in making this estimate.

There also will be some local government-recurring costs (man-hours) associated with keeping the selective routing files up to date. The master address file must be verified periodically, and must be updated to account for new streets and any public safety agency jurisdictional boundary changes caused by annexations. The telephone company also will require assistance in solving occasional file problems that will arise.

CHAPTER V. OTHER CONSIDERATIONS

The purpose of this chapter is to make the reader aware of several important non-technical areas that must be addressed if there is to be successful implementation and operation of a 911 system. This chapter discusses the following three 911-related areas in some detail: (1) the effective consideration and selection of a suitable management system for the 911 system, (2) consideration of various methods to finance initial and recurring 911 costs, and (3) a process to be used in determining the cost-effectiveness of various 911 alternatives. Two other areas critical to the success of 911 systems are public education and staff training. In this manual, documents that address these two areas are described briefly.

The material in Sections A, B and C of this chapter has been taken from two SRI reports which were prepared for the Illinois Commerce Commission using funds provided by the Illinois Law Enforcement Commission. Sections A and C are from Illinois Local Government 911 Planning Manual, SRI Project 4477, June 1976. The material presented in Section B comes from Statewide Considerations in Illinois 911 System Development, SRI Project 4477, June 1976.

A. 911 System Management Alternatives

1. Introduction. There are two basic management forms--joint powers and contract--commonly used to implement and operate a multi-agency 911 system. Due to the nature of 911, all 911 systems will need to be managed by one form or another.* Even a single-city 911 system will require some form of interagency agreement because fire, police, and ambulance agencies must be included. The most basic management form is a straight contract between two agencies or jurisdictions where one agrees to provide a specific service to the other. One common example is a contract between the sheriff and a town when the sheriff provides law enforcement for the town. Joint powers agreements generally are rather more complex and often involve a number of participants.

This section first will present a description of each form and will discuss their applicability to different situations. Next, a checklist which can be used to indicate the most appropriate management technique for any given system will be presented. This checklist should be completed for each alternative 911 configuration.

*This does not exclude special districts, but they are harder to implement and less acceptable for this type of service.

2. Joint powers agreements. A joint powers agreement is an intergovernmental agreement which creates a separate authority to perform a specific function. For example, all signees of the agreement would have one representative on a policy board created by the document. This policy board would collect and disperse operating funds, make overall policy decisions, and hear grievances. It would be fiscally and legally responsible for the provision of service in the designated area. Operating policy would be developed by a representative committee of user agencies who would determine how calls should be handled, what levels of service were to be provided, and other actual day-to-day decisions.

The joint powers agreement is particularly valuable in defusing a politically volatile situation. It provides an alternative to simple management by existing agencies, as well as neutral control of resources. It also provides a clearly identified authority which is accountable to the state, the user agencies, and the citizens. Thus, such an agreement is the most useful where there are two or more jurisdictions of comparable size and resources who are willing to cooperate in a joint venture of this kind.

In order to promote the acceptability of a joint powers management plan, several subjects should be addressed carefully by any group wishing to develop this form of 911 management.

- Any cost-sharing mechanism to determine user contributions should be based on some neutral criteria--such as population served, volume of calls per month, or size of original communications budget.
- Continuity of funding should be written into the agreement so that each agency's contribution is automatic. This might be accomplished by having both cities and counties dedicate a portion of their tax rate (determined by their total contribution) with the revenue paid directly to the 911 system.
- The prerogatives and obligations of signees should be specified clearly in the document itself, as should the prerogatives and obligations of the 911 communications system operation. This will reduce ambiguity and disagreement after the system has been implemented.
- Grievance procedures should be stated clearly, and be open to users and providers equally. The form of these proceedings should be publicized and easily accessible to all concerned.
- Levels of service to citizens and user agencies should be stated in the document in order to establish response criteria and to eliminate ambiguity. These levels of service also must meet statewide standards.

There are two major problems associated with this type of intergovernmental agreement, particularly when dealing with an area as sensitive as public safety communications. First, if there are several jurisdictions involved it may be difficult to develop an agreement acceptable to all of them. If it is apparent that this will be the case, the only solution is consideration of another alternative. The second problem is not quite so easily dealt with, and will arise whenever a joint powers agreement is signed which places the 911 communications facilities in an existing agency. For example, a group of cities signs an agreement with the county, but the 911 communications are operated from the sheriff's facilities. Since communications would be a separate function, the sheriff no longer would pay the wages of all of the communications personnel. This could create personnel problems.

3. Contractual agreements. Contract management of emergency communications is probably the simplest and most straightforward form. Essentially, an existing agency agrees to provide communications for others in the area. Thus the provider agency would be responsible for 911 answering and would bill user agencies according to some prearranged criteria. It is most feasible in areas where there is one acknowledged agency with the capability to operate a 911 system, or where other major agencies in the area agree that an acknowledged primary agency should operate 911.

The following are some considerations which should be discussed thoroughly by all participants and written into the contract:

- The billing criteria must be specified in the contract and should be unalterable unless a new contract is drawn and signed. This will eliminate user fears that the costs will grow arbitrarily. If the provider agency undertakes to finance the system, that also should be clearly stated.
- A user board should be established to develop and monitor operating policies and levels of service. It should have clearly defined recourses if the contract agency does not meet agreed-upon criteria.
- All operating policy and levels of service should be signed by contractor and contractee so that both are aware of the liabilities and prerogatives of their positions.
- The contract should provide for a grievance procedure which is accessible to user agencies and which has the authority to enforce provider compliance in cases of need.
- A provision for an annual user review should be written into the contract to provide an official forum for discussion.

Although this is a simple management form, it has more potential problems than those inherent in joint powers agreements. If the provider agency is viewed with any suspicion by potential user agencies, it may be extremely difficult to reach any consensus on operations and policy. This may be difficult to resolve, particularly if the contract form has inadequate provisions for user input. Even in an area where local agencies historically have worked closely with each other, these sorts of issues can arise.

4. Comparison of joint powers and contract management. The major differences between joint powers and contractual 911 management are presented in Table 5. These differences focus on the location of fiscal control and responsibility for the provision of service. Management by joint powers agreement provides a new line of authority for emergency communications. The Policy Board formed by the agreement is ultimately responsible for provision of service and has fiscal control of the communications system. In contrast, management by contract utilizes preexisting agencies. Fiscal control and responsibility for provision of service is given to an agency which is already providing services in the area. There is no new communications authority, and user agencies do not have the built-in input that is possible with a joint powers agreement.

However, each form is appropriate for certain types of situations, and while one proposed 911 configuration would best be managed by a joint powers agreement, another would be suited to contract. It is important to develop alternative management agreements as part of the process of defining specific 911 configurations. An alternative can be technically and operationally viable, but if the proposed management scheme is not acceptable to the participants, that alternative is not viable. This is illustrated by the three sample configurations in Rock Island County, Illinois, which are presented in Figure 5.

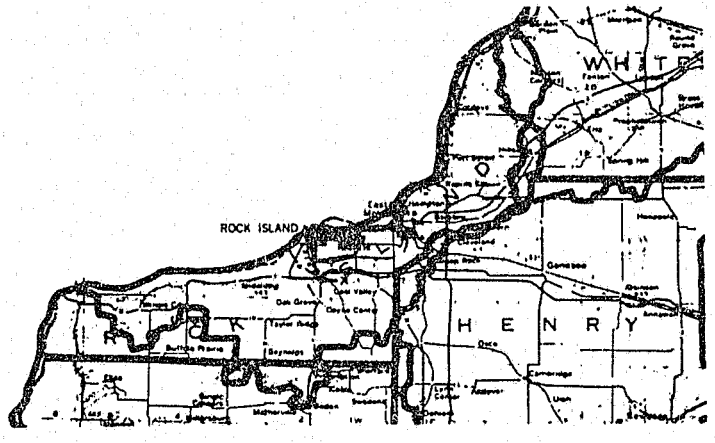
In example one, a countywide system, all public safety agencies and municipalities would share one answering point with the county and its agencies. Consequently, any management agreement would have to be acceptable to the entire county. For a system of this size, knowing that there are several large cities, a joint powers agreement probably would be the most appropriate.

In example two, the county is divided into three roughly equal portions, and most of the population is contained in the central section. Consequently, this section would be most likely to develop a joint powers agreement. The northern and southern ends would be more likely to develop management by contract since fewer jurisdictions and agencies would be involved.

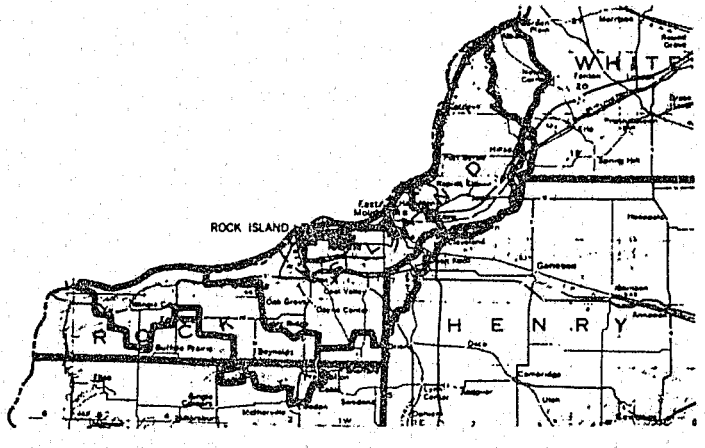
Table 5

COMPARISON OF JOINT POWERS AND CONTRACTS MANAGEMENT

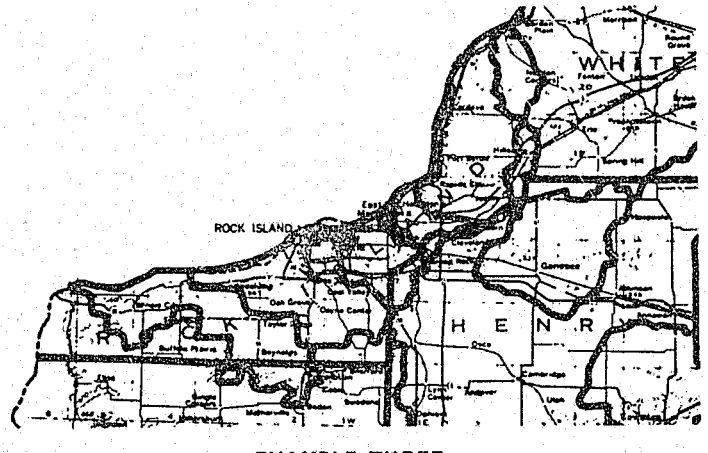
Measures	Joint Powers	Contracts
Applicability	Areas with equivalent municipalities or agencies	Areas where one agency is acknowledged leader
	Valuable in a politically volatile situation	Most straightforward management form
Authority	Policy Board	Existing agency
Fiscal Control	Policy Board	Existing agency
Provision of Service	Policy Board	Existing agency
Operating Policy	Users committee	Users committee
Grievance Procedures	Formal through Policy Board	Must be set up with contract
Levels of Service	Policy Board	Must be set up with contract



EXAMPLE ONE



EXAMPLE TWO



EXAMPLE THREE

FIGURE 5 REPRESENTATIVE 911 ALTERNATIVES FOR ROCK ISLAND COUNTY, ILLINOIS

In example three, the main centers of population are separated so it seems likely that each jurisdiction would operate 911 via an inter-agency contract. Again, a contractual agreement probably would be most suitable for the northern and southern parts of the county.

In each of these examples, special arrangements would have to be made with adjacent agencies and their PSAPs to arrange for appropriate handling of calls. As a general rule of thumb, the smaller the 911 system, the more agreements with adjacent agencies that will have to be developed.

5. Deciding on management format. Once the forms of management are understood, two considerations will indicate management techniques which would be the most successful.

- Is the alternative under discussion one with several agencies that each could technically operate a 911 system, or is a single agency most capable of providing 911? If there are several agencies of similar capability, it probably will be more productive to consider joint powers as the most feasible technique. If all agencies agree to allocate this function to one particular group, a contractual agreement also would be possible.
- If there is a single agency most capable of providing 911, will others in the area agree to a service so provided? The failure to reach an agreement on contract management indicates that the system would not be functional. In that event, the agencies should determine either that a joint powers agreement can work or the alternative should be eliminated as invalid.

If the initial meetings of potential 911 system members are able to produce a management form conditionally acceptable to all, then the alternative should be considered as viable for final consideration and analysis.

B. 911 System Finance Alternatives

One major concern of all local agencies and jurisdictions confronted with the necessity of implementing 911 is purely fiscal; they want to know who is going to pay for implementing and operating 911 systems.

Although local public safety agencies traditionally have been funded by local monies, there is an argument that 911 communications do not fit easily into this traditional role. When 911 is to be implemented in response to state legislation, local agencies do not feel that they should have to carry the total financial burden.

Additionally, some local agencies believe that the chief beneficiaries of the system will be transients. Consequently, they feel that the state should provide supplemental funds for 911 systems, since the beneficiaries will not necessarily be local. In the light of this argument, this section addresses the problems and benefits of two fiscal alternatives:

- Financing 911 from strictly local revenue
- State subvention financed by a statewide tax.

The section below presents a discussion of these fiscal alternatives and presents arguments for and against various funding alternatives. Section 2 presents a variety of funding mechanisms for both initial and recurring costs. This is not intended to be an exhaustive list of state and local taxes; only some of the more logical sources of funds are discussed. No single funding source can be considered optimal, but some are clearly more applicable to 911 financing than others.

1. Funding alternatives.

a. 911 funding at the local level. There are several reasons given for placing the burden of 911 cost on local rather than state tax bases. First, local governments traditionally have paid public safety communication costs as part of police and fire protection budgets. Although this is not usually a highly visible item in budgets, local governments still are paying these costs in almost every instance. Both tradition and custom point to local funding for communications costs. Further, it is argued that this is the best way to ensure that local governments do not develop unnecessarily sophisticated 911 systems, which can be a temptation if the state guarantees total payment.

Local funding insures economical resource utilization and relieves the state of the responsibility of developing a subvention plan, since state agencies need not enter the funding picture at all. From the local standpoint, such an arrangement insures minimal state interference in their communication systems.* As a matter of precedent, all 911 systems which are already in operation are paid for out of local revenues.

In a local funding situation, the communications costs would be divided between participant agencies. Existing 911 systems are funded in two basic ways. First, in jurisdictions with no municipal fire or ambulance district, a city can pay the bill in one of two ways: it simply can budget the 911 costs as part of police expenditures for the city, or the city clerk can pay the bill directly. In both situations,

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*State public safety agencies, of course, must participate in the local systems.

the local government has assumed direct responsibility for supplying 911. Second, where more than one tax district is involved, as in cities with a fire district supported by its own tax base, some method of dividing the cost must be developed. In Illinois, this 911 financing has taken two basic forms: the agency with the 911 answering point charges other users a flat rate, or user agencies pay in proportion to the number of calls received. For example, if the fire department received 15% of the 911 calls, it would pay 15% of the annual cost. The first form may be called fixed fee, the second, cost sharing.

Although the first funding method (with the city paying the bill directly) is used in many existing systems, it does suffer from severe limitations. It can be implemented in areas where a local government agency which encompasses the entire area to be served is willing and able to assume total responsibility. If there are multiple jurisdictions involved, a more complex funding method must be used.

As an example of possible cost sharing, assume a sample county exists with a population of approximately 25,000. It has three municipal police departments and a sheriff's department, with the sheriff serving municipalities that do not have their own police departments. As with the rest of the state, our sample county receives law enforcement service from the state police. In addition, there are several fire districts and a municipal fire department in the main town. Given this typical configuration, one agency which would have jurisdictional scope sufficient to provide all 911 communications would be the county government (the state police is another alternative). The county has the only tax base covering the area to be served. Funding by the county would imply that they would run the system.

In the case of subcounty or multicounty systems, some other method of finance would have to be used. A means of distributing the cost among various public safety agencies would have to be developed, and adjustments for boundary problems within the county would have to be made. Cost considerations become immediately more complex in such systems, and any funding mechanism would have to allow for this increase in complexity. In addition, if funding is done at a subcounty level it can cause an unequal tax burden. If a person lives in an incorporated area with a separate fire district, they could be taxed three times for the same service. The county, city, and fire district all depend on property tax as a major source of revenue; consequently, they all would be forced to use this tax base for their contribution to 911 system costs.

To date, most 911 systems cover one or, at the most, two municipalities. Therefore, their funding problems are relatively minor compared to the county-wide systems. These existing 911 systems generally had favorable boundary matches with the telephone service areas and their proponents felt that the benefits of 911 were worth the cost to their area. The systems were implemented from the grassroots in each community.

When 911 is mandated statewide, localities which previously had felt that 911 was not worth the cost are placed in the position of having to implement 911 systems. That is, areas which perhaps cannot afford 911 easily will have to develop it anyway. This can result in a severe burden in some areas of a state if the responsibility for funding 911 is placed solely on local governments. In Florida, SRI found that the more rural, thinly populated counties would be most burdened by 911 costs.* Since many counties have this characteristic, it may be hypothesized that the Florida rural conditions would be repeated elsewhere. For rural areas, implementation of a 911 system could result in sharp property tax increases or a steep rise in telephone costs. Either of these results would create an undue hardship for local residents who ultimately bear the financial burden. In the light of these considerations, an alternative to local finance should be considered.

b. 911 funding through the state. The major alternative to locally financed 911 is some form of fiscal assistance from the state. Because state governments have access to more tax instruments than the local governments, they have the capability of distributing the tax burden in the least regressive manner. Since all citizens would enjoy equal benefits from 911, it would be inequitable for some to pay more for the same service. Since all areas will have to maintain 911 systems and since some areas will be burdened more heavily by this system, equity of cost can be increased by equalizing the cost across the state.

It can be argued that state assistance in this matter would lead to uneconomical system development, since local governments would have no incentive to develop efficient systems. This possible effect can be mitigated by an efficient subvention schedule which can be modeled after federal revenue-sharing and grant programs. Such a schedule could strive for the following three objectives:

- Compensation for the unequal fiscal positions of the local governments participating in a 911 system by providing support of all recurring costs in proportion to the difficulty experienced by the local governments in financing 911 with local revenue.
- Encouragement of efficient and economical design and management of a 911 system by always requiring some local participation in meeting recurring costs.
- Encouragement of regionalization of 911, where appropriate, to provide better emergency services for the public.

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*911 in Florida: A System Concept, Final Report, SRI Project 3101, August 1974.

An additional objective can be achieved by offering a higher subvention rate to those areas which achieved the highest level of consolidation.

2. Sources of funds. There are a substantial number of potential funding mechanisms for 911. For the purpose of this discussion, they will be considered as appropriate for either initial or recurring costs. Of the two, recurring costs present the larger problem, since they must be paid annually.

The basic question to be resolved by state/local interaction is who will pay how much of both initial and recurring "bills." In the previous subsection, the state and local factors that must be considered in determining whether the state should subvent 911 funds were addressed. There was no discussion about the state and local sources of the funds. Consideration of various potential funding mechanisms is provided in this subsection to demonstrate both that the state has access to more sources of income and that it would be able to distribute the financial burden so that no one tax is increased disproportionately.

The following discussion looks at a variety of funding sources, but it is not recommended that any one of them necessarily carry the total 911 burden. It is possible that 911 could be implemented and operated in a state with no tax increase at all. However, if a tax increase is necessary, the following techniques would be "reasonable" for raising the additional funds. All the funding sources below are considered in terms of flexibility, equity, efficiency, and administrative structure.

A flexible funding mechanism is one that automatically reflects changes in the economic environment so that the rate which produces enough revenue in 1980 will still be adequate in 1990. Equity in financing is important in that 911 should impose an acceptable financial burden on everyone. The financial burden should not be regressive; equals should pay equally and unequals should pay in relation to their ability to pay. Efficiency may be defined as the proper use of resources, and a tax or pricing policy is efficient if it encourages proper use of 911 and inefficient if it encourages overuse or abuse of the system. Administrative considerations and effectiveness focus on the mechanisms necessary to collect and disburse the funds and the costs surrounding these mechanisms. These costs must be considered as part of the price of the system. Additionally, each source of recurring funds can be classified as appropriate for state or local collection.

a. State or local borrowing for initial funding. This is a method commonly employed by state or local governments who wish to finance capital improvements. It takes a variety of forms, but always involves either long- or short-term debts which are serviced by increases in the tax rate or base. The effect is to increase the annual

cost by a certain percentage until the debt is removed. Many states have statutory limitations on the amount of indebtedness which may be incurred, and many require prior consent by the electorate.

If local governments pay the initial costs, this system of finance might prove problematic (although funding alternatives exist) since it is possible that some areas already have reached their debt ceiling. If the state utilizes this mechanism, the total cost of all systems would be distributed across the state and some systems would be "subsidized" by other areas. However, this distribution can be justified by the fact that all citizens of the state will benefit equally from the service so that the financial burden should be dispersed equally. Although state or local indebtedness has several disadvantages, it is one funding mechanism that is controlled by the government that wishes to generate funds.

b. Federal funding sources for initial funding. The feasibility of financing 911 communication systems with federal funds is constrained by the availability of programs within the current structure of federal grants-in-aid. Because the federal government generally does not obligate itself to the continuing support of a program, federal grants generally cannot be used for recurring costs. In addition, federal agencies are generally reluctant to finance projects when the primary beneficiaries are local.

Although programs for public safety (and hence 911) have some of the characteristics of classic public benefit and consequently deserve some federal attention, most of the benefits accrue to the residents of local jurisdictions and the rationale for local or state support of public safety functions is traditionally strong.

However, some federal monies may be considered as possibilities for implementation costs of 911 systems as a part of general improvements in emergency communication. These monies are most likely to be Bureau of Justice Statistics (Department of Justice) funds and Emergency Medical (DHEW) funds. In addition, revenue sharing could provide some funds since it is not subject to federal constraints.

Revenue from the federal government is distributed to state and local governments each year under the Federal Revenue Sharing Project. These funds are not earmarked, and can be used for any state or local project; consequently, they could be used to support a 911 communications system. However, these funds generally have been the focal point of a variety of competing uses; to date, they have not grown very quickly. In addition, the cut-off date for the old program is near and the shape of any new revenue sharing program is not clear. Any available funds certainly could be used for initial 911 costs, but it may be unwise to depend upon revenue sharing for continuing support.

The LEAA was authorized by the Crime Control Act of 1973 to distribute funds to state governments for programs preventing and controlling crime. The great bulk of action funding is in the form of block grants to states. These grants are distributed through State Planning Agencies (SPAs). At this writing there is no LEAA guideline restricting funding of 911 systems, so 911 can be considered a program eligible for LEAA funds. Since the 911 system is a component of a broader public safety system that this agency is empowered to support, LEAA funds can be provided only for changes directly connected to law enforcement. Because of federal policy, this money could be used only for initial development and implementation; it would not be available for ongoing support.

The Emergency Medical Services Act passed in 1973 also provides some limited funds for 911 development and implementation. According to the act, 911 is one element of an optimal emergency medical response system. On this basis, some money should be available for implementation and development. It should be remembered that the amount of money available in the past from this source has been relatively small, so this should not be viewed as a major source of funding. It is granted most often on a state or regional basis.

c. The property tax for recurring funds. Property tax is a possible source of recurring funds for 911 communications systems. It could be collected at the county level, and would require no new administrative mechanisms or costs. This tax is particularly appropriate if local agencies must meet some portion of 911 costs, since it is a major source of locally controlled revenue. In addition, most local public safety agencies and programs currently are supported by property taxes, so there is precedent for its use.

However, there is some doubt as to the relative equity of property tax being used for this purpose. Some economists maintain that property tax is regressive because it fails to consider any economic index other than property ownership. Consequently, the burden falls as heavily on the poor property owner as it does on the wealthy owner, so that they are burdened unequally. Other economists maintain that since the property tax pays for public services which mostly benefit property owners, the tax is not regressive since it is on benefits received. Its relative equity in these circumstances is not clear, and both arguments should be considered.

With regards to efficiency, the property tax would constitute a hidden charge, which probably would not affect the public's use of 911. There may be problems with its flexibility, however. Because most of the states are still fairly rural, the assessed valuation in rural areas does not grow quickly, and the revenue from the property tax is not particularly flexible. In addition, there are limits on the rates that many local jurisdictions can levy.

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Under these conditions, the cost of 911 would have to be absorbed by a relatively fixed tax base, creating a situation where rate adjustments might be frequently necessary if the cost of 911 were to increase more rapidly than the tax revenue. In addition, the cost of a 911 system could create a severe burden in some rural areas with a relatively low assessed valuation, particularly where they are approaching their tax-rate limit.

d. The sales tax for recurring funds. Sales tax is a possible source of statewide funds for 911 communications. Since monies from the sales tax already are being redistributed to both city and county governments in some states, no new administrative mechanisms would be required. However, it is likely that a new formula would have to be developed for 911 subvention.

The current practice of returning a percentage of the money collected in each jurisdiction by sales tax would not correspond necessarily with the cost of 911 in that area. For example, a rural jurisdiction could have a low volume of sales (since most of the populace might shop in adjoining areas), yet the cost of their 911 system might be relatively high.

Thus, although sales tax is probably flexible enough on a statewide level to fund 911 communications without constant rate adjustments, funds collected by it would have to be redistributed on the basis of need. In addition, the sales tax is somewhat regressive; any sales tax support for 911 would be regressive as well. Since there is little correspondence between use of 911 and payment of a retail sales tax, no argument about benefits received can offset this basic inequity. This tax would have little effect on the frequency of 911 calls, since the cost would not be associated with the call by system users. Thus, it would not affect the efficient use of 911.

e. The income tax for recurring funds. State-administered income tax is another potential source of funds for 911 communications. It would be collected by the state, and a method of subvention would have to be developed. There would not be any new administrative costs, except those necessary to administer the subvention schedule. Income tax is inherently more equitable than property or sales tax, since it takes into account variations in income. That is, it is the least regressive existing source of funds. If it is assumed that all residents will benefit equally from the improved access to public safety services, then income tax is an equitable method of financing 911.

It would be efficient as well, since such a hidden tax is unlikely to affect 911 use. It also probably would be sufficiently flexible, as income tax reflects growth in the economy. Consequently, few rate adjustments would be necessary except in the case of a recession. However, there is generally strong resistance to income tax increases in most states. This fact could make tax financing of 911 untenable in spite of its potential value.

f. The telephone excise tax for recurring funds. An excise tax on telephone usage is another potential source of 911 support. It has the advantage of a clear coincidence between system benefactors and beneficiaries. Citizens without a phone, and consequently with limited 911 access, would not contribute to the system.

The current federal excise tax on telephone use is being phased out gradually at a rate of 1% per year. Telephone companies routinely collect this tax and forward it to the federal government, so no additional administrative mechanism would be required. It would require some modifications to the existing collection technique, since the tax revenue would have to be forwarded to a new place. By replacing a federal tax with a state tax, no new burden is placed upon the citizen: the tax already is being collected and used for a different purpose.

In most areas, a 1 or 2% telephone excise tax would be more than adequate to finance 911. Since telephone use is increasing, it is probable that this tax would prove sufficiently flexible as well. It has been argued that retaining a portion of this tax makes telephone service less accessible to the public. This is a judgement that states must make with the understanding that the tax already is included in the bill. If it is making telephone service less accessible, such an effect is already present. Historically, the federally imposed excise tax has varied from 3 to 10%.

Although this tax is somewhat regressive, this regression is modifed when the total bill is taxed, as telephone usage tends to reflect users' incomes. Since such a tax would not be connected to individual calls for assistance, it is efficient. It would require state legislation, but not the imposition of a new tax. A subvention schedule would have to be developed, but this problem exists with all state-collected taxes.

g. Public utilities tax for recurring funds. Another major contributor to many state general funds is the public utilities tax. This differs from all preceding taxes in that it is not levied directly on the individual but rather on the suppliers of electricity and gas and the transmitters of messages within the state.

This tax would be relatively regressive because rate increases to accommodate 911 would not be correlated with the income of the customer. A wealthy customer would pay no more than a poor one. In addition, it is relatively inequitable because gas and electricity usage are not related to 911 access. Thus, even those people without phones would pay for 911. This mechanism probably would be sufficiently flexible to support the ongoing 911 system costs, and it would not require any new administrative structure. It would, like all state-collected taxes, require a subvention formula.

There are advantages to this tax. It is currently a major contributor to many state general funds, and does tax telephone utilities. As a result, it is more linked to 911 access than the gereral sales tax or property tax.

C. Cost-effectiveness Analysis of Alternatives

Having completed the design and costing process described in the earlier sections of this manual, planners now should be ready to use the information they have accumulated as a basis for selecting a 911 system to serve their planning area. Each 911 system to be evaluated will have five basic features: (1) a specific geographic area which contains a number of jurisdictions, agencies, and telephone exchanges (plus perhaps parts of other jurisdictions and agencies), (2) a set of call handling procedures for the included agencies, (3) a selected PSAP, (4) estimated initial and recurring costs, and (5) a method of management. This section describes a method of ranking these (and other) 911 system features.

Table 6 contains a matrix which planners can use to rank the alternatives (the elements in this table will be discussed later in this section). It is probable that all planners of a given 911 system will not agree on the ranking of benefit measures for each alternative--particularly benefits which are not easily measured--so each planner should rank the benefit measures independently. After individual planners have ranked the alternatives, the rankings should be evaluated and a consensus developed.

Table 6 contains a mixture of quantitative (measurable) benefit measures and qualitative (unmeasurable or subjective) benefit measures. For example, the cost of the telephone system is a quantitative measure, while the desires of an agency for a particular configuration is a qualitative measure.

In using Table 6, 911 planners should rank the alternatives for each benefit measure. The best alternative should receive the lowest number (one), the worst alternative should receive the highest number (equal to the total number of alternatives being considered), and the other alternatives should be ranked in ascending order of undesirability. For example, if four alternatives are being ranked for "Installation Costs," the alternative with the lowest installation cost would be ranked 1, the alternative with the next lowest cost would be ranked 2, the third lowest cost alternative would be ranked 3, and the most expensive alternative would be ranked 4.

The first step in the selection process is to assign each alternative a number to be used in the Table 6 matrix. Each planner should use Table 6 to develop ratings for each benefit measure and an average ranking for each alternative. In the balance of this section, the benefit measures will be discussed.

Table 6

RANKING OF ALTERNATIVES

Benefit Measures*	Alternative Number								
	1	2	3	4	5	6	7	8	9
Installation Costs									
Facility Costs									
Personnel Costs									
Monthly Telephone Costs									
Costs to Telephone Companies									
Boundary Match									
Calls Using Direct Dispatch									
Call Handling Agreement									
Match to Current Agreements									
Central Office Capabilities									
Reliability of Power									
Personnel Utilization									
Agency Desires									
Jurisdiction Desires									
Public Benefit									
System Management									
Total Initial Costs									
Total Recurring Costs									
Average Benefit Ranking									

*All benefit measures need not be used. Each 911 planner can select a subset of these measures that they wish to use. Clearly, additional benefit measures also can be selected.

The first two benefit measures are initial 911 system costs. Telephone installation costs are entered in column 1 for each alternative. If an alternative requires facility modification costs, or if a new facility is needed for a PSAP, those costs should be determined and used to rank the alternatives--least expensive to most expensive. The sum of these costs should be entered under "Total Initial Costs" (third row from bottom in Table 6) to provide an overall initial cost ranking.

"Personnel Costs" and "Monthly Telephone Costs" (the next two benefit measures) are the ongoing costs of the 911 systems. All personnel and telephone costs for all 911 systems in the 911 planning region should be included. For example, if an alternative in a 911 planning region consists of two municipal 911 systems and one county 911 system, the sum of the costs of personnel and monthly telephone charges for all three systems should be determined and used in the ranking process. If, on the other hand, one 911 alternative for a 911 planning area has that area as part of a larger 911 system, then the 911 planning area's share of the cost of the larger 911 system would be used in the ranking process.

The sum of personnel and recurring telephone costs should be determined for each alternative and used in the "Total Recurring Costs" row (next to last row in Table 6) to provide an overall recurring cost ranking. The final cost element, "Costs to Telephone Companies," should be provided by the local telephone companies as an indication of the relative cost impact of the alternatives on the telephone companies.

The remaining elements in Table 6 are benefit measures, some of which are objective and some of which are subjective. The first of these is "Boundary Match," meaning the extent to which the alternatives provide a match between agency/jurisdictional and telephone boundaries. Here the best match should receive the highest ranking (lowest number) and the poorest match the lowest ranking (highest number).

Since direct dispatch is the most efficient form of 911 call handling, the number of calls processed by that method should be used as a means of ranking alternatives. For example, if one alternative handled 60% of the 911 calls by direct dispatch while a second alternative handled 40%, then the first alternative should receive the best ranking.

Equally important is the "Call Handling Agreement" benefit measure. The extent to which agencies in a 911 system alternative are satisfied with the call handling techniques available to them certainly will influence the chances of success of that system. This is basically a technical and operational problem in which the participants in a 911 system must reach agreement on call-handling techniques in that system or select an alternative. Ranking alternatives with this benefit measure will reflect the satisfaction of the agencies with the agreements that have been worked out in earlier planning steps.

In many areas, the agencies and jurisdictions in 911 planning areas will have some current agreements for working together to provide services. Additionally, they may have participated in joint-study efforts to develop common bases for agreements. Matching alternative system boundaries to existing areas of agreement or to existing service areas is to be ranked under "Match to Current Agreements." Examples of matches between agencies and system boundaries would be: fire protection agencies bound by mutual-aid pacts, emergency medical service areas, city police and/or sheriffs service areas, and any regional service areas. System alternatives that fragment these service areas are less desirable than those that do not.

The "Central Office Capabilities" column of Table 6 refers to the ability of telephone company central offices to provide sophisticated 911 service. By locating a PSAP in the service area of the more modern central offices, users may gain some services not possible from older central offices. Telephone company representatives should provide information on the ranking of the alternatives using this benefit measure.

The "Reliability of Power" at the proposed PSAPs can affect the selection of alternatives. Here 911 planners should rank the alternatives on both the reliability of commercial power and the availability of backup power. Costs also should be considered in ranking by this benefit measure.

A very important benefit measure is that of "Personnel Utilization." The extent to which personnel already involved in public safety communication can be used for 911 operations is a measure of the cost-effectiveness of the system. Comparing the number of personnel required at the PSAP to the number of personnel already providing dispatching at the PSAP location is a good method of evaluating personnel utilization. Additionally, the effectiveness of personnel utilization can be ranked by comparing the total number of 911 and dispatch personnel required for the various alternatives. Clearly, the 911 alternative that requires the fewest additional personnel is the best according to this benefit measure.

The next two benefit measures--"Agency Desires" and "Jurisdiction Desires"--are included to provide the agencies and jurisdictions, respectively, with a means of ranking the alternatives based on their subjective feelings toward their desirability. These rankings can reflect such factors as political interactions of the jurisdictions, service orientations of the agencies, anticipated improvement in service, and acceptability to the public.

The provision of 911 is, as pointed out earlier, a major "Public Benefit." Therefore, the ranking provided for this benefit measure should be based on such factors as minimum overall costs to the public, minimum delays in call handling, and most effective use of public

safety resources. Public members of the 911 committee can contribute their understanding of community desires to the ranking process by way of this benefit measure.

The final benefit measure that can be ranked is that of "System Management." 911 planners will have considered previously (see Section V-A) the management form and content for controlling and operating the 911 systems. These considerations will provide the planners with a means of ranking the alternatives based on the relative difficulty in achieving management agreements among participants in each system. Therefore, if a 911 system requires the combination of four agencies, and two agencies want joint powers while two agencies want contract management, this would be a lower ranked system (for this benefit measure) than would be the case if all four agencies favored the same management form.

The last row of Table 6 is provided to average the benefit (not cost) measures and provide an overall ranking of the alternatives. The lowest number corresponds to the best system. It is recognized that some of the benefit measures will be more important to some members than others. These preferences for certain benefit measures should be brought out at planning meetings and openly discussed.

Planners then should put together a final ranking of alternatives using averages of the rankings provided by each involved planner. This benefit ranking and costs of the alternatives then should be discussed by all planners to select the most cost-effective alternative for the 911 planning area.

D. Public Education

In the questionnaire used to develop the Directory of 911 Systems (see Bibliography at the back of this manual), SRI asked 911 system users to describe their most pressing problems. Public education of the correct use of 911 was the problem cited most.

Rather than discuss public education in this manual, planners are referred to a separate document (see Bibliography) which is a guideline manual on 911 service-related public-education activities. That manual addresses specific problems a community may encounter, how to resolve these problems, and step-by-step procedures for preparing a 911 public education program.

E. Staff Training

The second most cited problem in the responses to the SRI questionnaire was effective training of 911 call answerers. This topic is also discussed in a seperate document (see Bibliography), which is a guideline manual on 911 service-related staff training and employment practices. That manual addresses staff training by identifying the work functions and training requirements for 911 center staff, and examines the typical training practices in current use. In addition, the manual identifies and examines the typical process used to screen applicants for 911 center employment. Alternative training and employment practices also are identified, discussed and recommended for further development.

APPENDIX A

TABLES FOR DETERMINING THE NUMBER OF CALL ANSWERERS REQUIRED PER SHIFT

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TABLES FOR DETERMINING THE NUMBER OF CALL ANSWERERS REQUIRED PER SHIFT

The purpose of the tables of information in this Appendix is to provide assistance to local planners in estimating the number of 911 call answerers that are required on each shift at the PSAP. The source of the data contained in these tables and the procedure for using them are discussed in Section II-G-3-a.

Table A-1

BUSY-HOUR REQUIREMENT FOR CALL ANSWERERS
(90% of the Calls Answered Within 10 Seconds)

Number of Busy-Hour Call Answerers	Busy-Hour Call Volume							
	10 s*	15 s	20 s	25 s	30 s	35 s	40 s	45 s
1	78	41	27	20	16	13	11	9
2	333	189	129	97	77	64	54	47
3	637	375	260	197	157	131	112	98
4	960	577	404	308	247	206	177	154
5	1293	788	556	426	343	287	246	215
6	1632	1006	713	548	443	371	318	278
7	1975	1227	874	673	545	457	393	344
8	2321	1451	1038	801	650	545	469	411
9	2670	1677	1203	931	756	635	546	479
10	3019	1905	1371	1062	864	726	625	548
11	3370	2134	1539	1195	973	818	705	618
12	3722	2364	1709	1329	1082	911	785	689
13	4075	2595	1879	1463	1193	1005	866	761
14	4428	2827	2051	1598	1304	1099	948	833
15	4782	3060	2223	1734	1416	1194	1030	905
16	5137	3293	2396	1870	1528	1289	1113	978
17	5492	3527	2569	2007	1641	1385	1196	1051
18	5847	3761	2742	2145	1754	1481	1279	1125
19	6203	3996	2916	2282	1868	1578	1363	1199
20	6559	4231	3091	2420	1982	1674	1447	1273
21	6915	4466	3265	2559	2096	1772	1532	1348
22	7272	4702	3440	2697	2211	1869	1616	1423
23	7628	4938	3616	2836	2326	1967	1701	1497
24	7985	5174	3791	2976	2441	2065	1786	1573
25	8342	5410	3967	3115	2556	2163	1872	1648
26	8700	5646	4143	3255	2672	2261	1957	1723
27	9057	5883	4319	3394	2787	2359	2043	1799
28	9414	6119	4495	3534	2903	2458	2128	1875
29	9772	6356	4671	3675	3019	2557	2214	1951
30	10130	6593	4848	3815	3135	2656	2300	2027

*Average effective call-answerer occupied time per call

s = seconds

Table A-1 (Continued)

Number of Busy-Hour Call Answerers	Busy-Hour Call Volume							
	50 s	55 s	60 s	65 s	70 s	75 s	80 s	85 s
1	8	7	6	6	5	5	5	4
2	42	37	34	31	28	26	24	23
3	86	78	70	64	59	55	51	48
4	137	123	111	102	94	87	81	76
5	191	171	156	142	131	122	113	106
6	247	222	202	185	170	158	147	138
7	306	275	250	229	211	196	182	171
8	365	329	299	274	252	234	218	205
9	426	384	349	319	295	273	255	239
10	488	439	399	366	338	313	292	274
11	550	496	451	413	381	354	330	309
12	614	553	503	461	425	395	368	345
13	678	611	555	509	470	436	407	382
14	742	669	608	558	515	478	446	418
15	807	727	662	607	560	520	485	455
16	872	786	715	656	606	563	525	492
17	937	845	769	706	652	605	565	530
18	1003	905	824	756	698	648	605	567
19	1069	965	878	806	744	691	645	605
20	1136	1025	933	856	791	734	686	643
21	1202	1085	988	906	837	778	726	681
22	1269	1145	1043	957	884	822	767	719
23	1336	1206	1098	1008	931	865	808	758
24	1404	1267	1154	1059	979	909	849	796
25	1471	1328	1210	1110	1026	953	890	835
26	1539	1389	1265	1162	1073	997	931	873
27	1606	1450	1321	1213	1121	1042	973	912
28	1674	1512	1377	1265	1169	1086	1014	951
29	1742	1573	1434	1316	1217	1131	1056	990
30	1811	1635	1490	1368	1264	1175	1098	1029

Table A-1 (Concluded)

Number of Busy-Hour Call Answerers	Busy-Hour Call Volume						
	90 s	95 s	100 s	105 s	110 s	115 s	120 s
1	4	4	4	3	3	3	3
2	21	20	19	18	17	16	16
3	45	42	40	38	36	34	33
4	71	67	64	60	57	55	52
5	100	94	89	85	80	77	73
6	130	122	116	110	105	100	95
7	161	152	143	136	130	124	118
8	192	182	172	163	155	148	142
9	225	212	201	191	181	173	165
10	258	243	230	219	208	199	190
11	291	275	260	247	235	224	214
12	325	307	290	276	262	250	239
13	359	339	321	305	290	277	265
14	393	371	352	334	318	303	290
15	428	404	383	364	346	330	316
16	463	437	414	393	374	357	342
17	498	471	446	423	403	385	368
18	534	504	477	453	432	412	394
19	569	538	509	484	460	439	420
20	605	571	541	514	489	467	447
21	641	605	573	545	518	495	473
22	677	639	606	575	548	523	500
23	713	673	638	606	577	551	527
24	749	708	670	637	606	579	554
25	786	742	703	668	636	607	581
26	822	777	736	699	666	635	608
27	859	811	769	730	695	664	635
28	896	846	801	761	725	692	662
29	932	881	834	793	755	721	689
30	969	915	867	824	785	749	716

Table A-2

BUSY-HOUR REQUIREMENTS FOR CALL ANSWERERS
(90% of the Calls Answered Within 15 Seconds)

Number of Busy-Hour Call Answerers	Busy-Hour Call Volume							
	10 s*	15 s	20 s	25 s	30 s	35 s	40 s	45 s
1	104	52	33	23	18	14	12	10
2	394	222	148	109	86	70	59	51
3	721	424	291	218	173	143	121	105
4	1060	640	446	337	269	223	190	165
5	1405	862	607	462	371	308	263	229
6	1754	1088	772	591	475	396	339	295
7	2105	1317	939	722	583	486	416	363
8	2457	1547	1109	855	692	578	496	433
9	2811	1780	1280	990	802	672	576	504
10	3166	2013	1452	1125	914	766	658	576
11	3521	2247	1625	1262	1026	861	740	648
12	3877	2481	1799	1399	1139	957	823	721
13	4233	2716	1974	1537	1253	1054	907	795
14	4590	2952	2148	1676	1367	1151	991	869
15	4947	3188	2324	1815	1482	1248	1076	944
16	5304	3424	2500	1954	1597	1346	1161	1019
17	5662	3661	2676	2094	1712	1444	1246	1094
18	6019	3898	2852	2234	1828	1542	1331	1169
19	6377	4135	3029	2374	1944	1641	1417	1245
20	6735	4372	3205	2515	2060	1740	1503	1321
21	7093	4610	3382	2655	2177	1839	1589	1397
22	7452	4848	3560	2796	2293	1939	1676	1474
23	7810	5085	3737	2937	2410	2038	1762	1550
24	8168	5323	3915	3078	2527	2138	1849	1627
25	8527	5561	4092	3220	2644	2238	1936	1704
26	8886	5800	4270	3361	2762	2338	2023	1781
27	9244	6038	4448	3503	2879	2438	2110	1858
28	9603	6276	4626	3644	2996	2538	2198	1935
29	9962	6514	4804	3786	3114	2638	2285	2013
30	10321	6753	4982	3928	3232	2739	2372	2090

*Average effective call-answerer occupied time per call

s = seconds

Table A-2 (Continued)

Number of Busy-Hour Call Answerers	Busy-Hour Call Volume							
	50 s	55 s	60 s	65 s	70 s	75 s	80 s	85 s
1	9	8	7	6	6	5	5	4
2	45	40	36	33	30	28	26	24
3	92	82	74	68	62	57	53	50
4	145	130	118	107	98	91	85	79
5	202	181	164	149	137	127	118	110
6	261	234	212	193	178	165	153	143
7	322	289	262	239	220	204	189	177
8	384	345	312	285	263	243	227	212
9	447	401	364	333	307	284	264	247
10	511	459	417	381	351	325	303	283
11	576	518	470	430	396	367	342	320
12	641	576	523	479	441	409	381	357
13	707	636	577	528	487	452	421	394
14	773	696	632	578	533	494	461	431
15	840	756	687	629	580	538	501	469
16	907	816	742	679	626	581	542	507
17	974	877	797	730	674	625	582	545
18	1042	938	853	781	721	669	623	584
19	1109	999	909	833	768	713	665	622
20	1177	1061	965	884	816	757	706	661
21	1245	1122	1021	936	864	801	747	700
22	1314	1184	1077	988	912	846	789	739
23	1382	1246	1134	1040	960	891	831	778
24	1451	1308	1191	1092	1008	936	873	818
25	1520	1371	1248	1144	1056	981	915	857
26	1589	1433	1305	1197	1105	1026	957	897
27	1658	1496	1362	1249	1153	1071	999	936
28	1727	1558	1419	1302	1202	1116	1041	976
29	1796	1621	1476	1354	1251	1161	1084	1016
30	1866	1684	1533	1407	1300	1207	1126	1056

Table A-2 (Concluded)

Number of Busy-Hour Call Answerers	Busy-Hour Call Volume						
	90 s	95 s	100 s	105 s	110 s	115 s	120 s
1	4	4	4	3	3	3	3
2	22	21	20	19	18	17	16
3	47	44	41	39	37	35	34
4	74	70	66	62	59	56	54
5	104	98	92	87	83	79	75
6	134	127	120	113	108	103	98
7	166	157	148	140	133	127	121
8	199	187	177	168	160	152	145
9	232	219	207	196	187	178	170
10	266	251	237	225	214	204	195
11	300	283	268	254	242	230	220
12	335	316	299	283	270	257	245
13	370	349	330	313	298	284	271
14	405	382	362	343	326	311	297
15	441	416	393	373	355	339	323
16	477	450	425	404	384	366	350
17	513	484	458	434	413	394	376
18	549	518	490	465	442	422	403
19	585	552	523	496	472	450	430
20	622	587	555	527	501	478	457
21	658	621	588	558	531	506	484
22	695	656	621	589	561	535	511
23	732	691	654	621	591	563	538
24	769	726	687	652	621	592	566
25	806	761	720	684	651	621	593
26	843	796	754	715	681	649	621
27	881	831	787	747	711	678	648
28	918	867	821	779	741	707	676
29	956	902	854	811	772	736	704
30	993	938	888	843	802	765	732

Table A-3
BUSY-HOUR REQUIREMENT FOR CALL ANSWERERS
(90% of the Calls Answered Within 20 Seconds)

Number of Busy-Hour Call Answerers	Busy-Hour Call Volume							
	10 s*	15 s	20 s	25 s	30 s	35 s	40 s	45 s
1	129	63	39	27	20	16	13	11
2	442	250	166	121	94	77	64	55
3	780	464	318	237	187	154	130	112
4	1127	687	480	362	288	238	202	175
5	1478	915	646	492	394	327	278	241
6	1831	1146	816	625	503	418	356	310
7	2186	1379	987	760	613	511	437	381
8	2541	1613	1160	896	725	606	519	452
9	2897	1848	1335	1034	838	702	601	525
10	3254	2083	1509	1172	952	798	685	599
11	3611	2320	1685	1311	1067	895	769	673
12	3969	2556	1861	2451	1182	993	854	748
13	4327	2793	2037	1590	1297	1092	939	823
14	4685	3031	2214	1731	1413	1190	1025	899
15	5043	3268	2391	1871	1530	1289	1111	975
16	5401	3506	2568	2012	1646	1388	1198	1051
17	5706	3744	2746	2153	1763	1488	1284	1127
18	6118	3982	2923	2295	1880	1588	1371	1204
19	6477	4220	3101	2436	1998	1688	1458	1281
20	6836	4459	3279	2578	2115	1788	1545	1358
21	7195	4697	3457	2720	2233	1888	1632	1435
22	7554	4936	3636	2862	2351	1989	1720	1513
23	7913	5174	3814	3004	2469	2089	1808	1590
24	8272	5413	3992	3146	2587	2190	1895	1668
25	8631	5652	4171	3288	2705	2291	1983	1746
26	8990	5891	4350	3431	2823	2392	2071	1824
27	9350	6130	4528	2573	2941	2493	2159	1901
28	9709	6369	4707	3716	3059	2594	2247	1980
29	10068	6608	4886	3858	3178	2695	2335	2058
30	10428	6847	5065	4001	3296	2796	2424	2136

*Average effective call-answerer occupied time per call

s = seconds

Table A-3 (Continued)

Number of Busy-Hour Call Answerers	Busy-Hour Call Volume							
	50 s	55 s	60 s	65 s	70 s	75 s	80 s	85 s
1	10	8	8	7	6	6	5	5
2	48	43	38	35	32	29	27	25
3	98	87	78	71	65	60	56	52
4	154	137	123	112	103	95	88	82
5	213	190	171	156	143	132	123	114
6	274	245	221	202	185	171	159	148
7	336	301	272	248	228	211	196	183
8	400	359	325	296	272	252	234	219
9	465	417	378	345	317	293	273	255
10	531	479	432	394	363	336	312	292
11	597	536	486	444	409	378	352	329
12	664	596	541	495	455	422	392	367
13	731	657	596	545	502	465	433	405
14	799	718	652	596	549	509	474	443
15	867	780	708	648	597	553	515	482
16	935	841	764	699	644	597	556	520
17	1003	903	820	751	692	642	598	559
18	1072	965	877	803	740	686	639	598
19	1141	1027	934	855	789	731	681	638
20	1210	1090	991	908	837	776	723	677
21	1279	1152	1048	960	886	821	766	717
22	1348	1215	1105	1013	934	867	808	756
23	1418	1278	1163	1066	983	912	850	796
24	1488	1341	1220	1119	1032	958	893	836
25	1557	1404	1278	1172	1081	1003	936	876
26	1627	1467	1336	1225	1130	1049	978	916
27	1697	1531	1393	1278	1179	1095	1021	956
28	1767	1594	1451	1331	1229	1141	1064	997
29	1837	1658	1509	1384	1278	1187	1107	1037
30	1907	1721	1567	1438	1328	1233	1150	1077

Table A-3 (Concluded)

Number of Busy-Hour Call Answerers	Busy-Hour Call Volume						
	90 s	95 s	100 s	105 s	110 s	115 s	120 s
1	4	4	4	4	3	3	3
2	23	22	21	19	18	17	17
3	49	46	43	41	39	37	35
4	77	72	68	64	61	58	55
5	107	101	95	90	85	81	78
6	139	131	123	117	111	106	101
7	172	162	153	144	137	131	125
8	205	193	182	173	164	156	149
9	239	225	213	202	192	182	174
10	274	258	244	231	219	209	199
11	309	291	275	261	248	239	225
12	344	324	307	291	276	263	251
13	380	358	339	321	305	291	277
14	416	392	371	351	334	318	304
15	452	426	403	382	363	346	331
16	489	461	436	413	393	379	357
17	525	495	468	444	422	403	384
18	562	530	501	475	452	431	412
19	599	565	534	507	682	459	439
20	636	600	568	538	512	488	466
21	674	635	601	570	542	517	494
22	711	671	634	602	572	546	521
23	748	706	668	634	603	575	549
24	786	741	702	666	633	604	577
25	824	777	735	698	664	633	605
26	861	813	769	730	694	662	632
27	899	849	803	762	725	691	660
28	937	884	837	794	756	721	688
29	975	920	871	827	786	750	717
30	1013	956	905	859	817	779	945

APPENDIX B

911 SYSTEM DESIGN AND COSTING WORKSHEETS

APPENDIX B

911 SYSTEM DESIGN AND COSTING WORKSHEETS

The tables in this Appendix have been developed for the following purposes: to provide the 911 system planner with convenient worksheets to serve as the basis for detailed discussions with the telephone company and with equipment vendors, and to assist in obtaining and keeping track of cost estimates. Each of the seven tables in this Appendix is discussed briefly in Chapter IV. Use a separate set of tables for each 911 system alternative that is investigated.

Table B-1

TELEPHONE LINES WORKSHEET

PSAP Name: _____

Element	Quantity	Cost	
		Initial	Monthly
911 Lines per Central Office (CO):			
CO Name: _____	_____	_____	_____
CO Name: _____	_____	_____	_____
CO Name: _____	_____	_____	_____
CO Name: _____	_____	_____	_____
CO Name: _____	_____	_____	_____
911 Lines--Direct Trunked (Total)	_____	_____	_____
911 Lines--Tandem Trunked (Total)	_____	_____	_____
Private Tie Lines or Control Office Transfer Lines to Each Dispatch Center (DC):			
DC Name: _____	_____	_____	_____
DC Name: _____	_____	_____	_____
DC Name: _____	_____	_____	_____
DC Name: _____	_____	_____	_____
DC Name: _____	_____	_____	_____
Nonpublished Seven-Digit Numbers	_____	_____	_____
Published Seven-Digit Numbers	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Table B-2

TELEPHONE TERMINAL EQUIPMENT WORKSHEET

PSAP Name: _____

Element	Quantity	Cost	
		Initial	Monthly
Handsets			
Pushbutton Sets: No. of Buttons			
Call Directors: No. of Buttons			
Key Telephone System: Type			
Automatic Call Distributor: Type			
Switchboard: Type			
High-Speed Dialer: Number Capacity			
Abbreviated Dialing: Number Capacity			
Special Call Transfer Equipment: Type:			
911 Display and Transfer Units			
ALI Displays			
Logging Teletypewriters			
ANI Master Controllers			
ANI Auxiliary Controllers			
ALI Master Controllers			
ALI Auxiliary Controllers			

Table B-3

TELEPHONE SERVICE FEATURES WORKSHEET

PSAP Name:_____

Element	Cost Initial	Cost Monthly
Place a check mark following each feature that is desired:		
Called Party Hold:_____	_____	_____
Forced Disconnect:_____	_____	_____
Ringback:_____	_____	_____
Idle Circuit Tone Application:_____	_____	_____
Switchhook Status Indication:_____	_____	_____
Automatic Number Identification:_____	_____	_____
Automatic Location Identification:_____	_____	_____
Fixed Transfer:_____	_____	_____
Selective Transfer:_____	_____	_____
Manual Transfer:_____	_____	_____
Default Routing:_____	_____	_____
Alternate Routing:_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Table B-4

OTHER TELEPHONE SYSTEM ELEMENTS WORKSHEET

PSAP Name:_____

Element	Quantity	Cost	
		Initial	Monthly
Telephone Call Counters (Registers)			
Recorded Announcement Equipment			
Uninterruptable Power Source			
List below any other telephone system related costs, including any telephone costs to the dispatch centers being served by the PSAP:			

Table B-5

PERSONNEL WORKSHEET

PSAP Name: _____

Element	Quantity	Monthly Cost
Call Answerers		
Call Answerer/Dispatchers		
Supervisors		
PSAP Director		
Secretary		
Clerk		
List below any other personnel that may be needed:		

Table B-6

OTHER EQUIPMENT WORKSHEET

PSAP Name:_____

Element	Quantity	Cost	
		Initial	Monthly
Master Audio-Logging Tape Recorder:			
No. of Channels_____			
Tape Size_____			
Audio Recording Tape			
Tape Reproducer (Playback) Equipment			
Individual Answering Position Recorders			
Intercom System			
No. of Stations_____			
Standby Emergency Power			
Incident Location/Agency Cross Index			
List below any other equipment that may be needed:			

Table B-7

ANCILLARY EXPENSES WORKSHEET

PSAP Name:_____

Element	Cost	
	Initial	Monthly
Facility Modification or Construction		
Staff Training		
Public Education		
Miscellaneous Office Supplies		
Local Government Costs (manhours) to Develop and Maintain the Selective Routing Data Files		
List below any other ancillary costs:		

GLOSSARY

ACD--See AUTOMATIC CALL DISTRIBUTOR.

ALI--See AUTOMATIC LOCATION IDENTIFICATION.

ALTERNATE ROUTING--A selective routing feature which allows 911 calls to be routed to a designated alternative location if all incoming 911 lines to the primary PSAP are busy or if the primary PSAP closes down for a period.

ANI--See AUTOMATIC NUMBER IDENTIFICATION.

ATTENDANT--Telephone company term for call answerer.

AUTOMATIC CALL DISTRIBUTOR (ACD)--Equipment used to distribute large volumes of incoming calls in approximate order of arrival to call answerers not already working on calls, or to "store" calls until call answerers become available.

AUTOMATIC LOCATION IDENTIFICATION (ALI)--A system capability that enables the automatic display of information defining the geographical location of the telephone used to place a 911 call.

AUTOMATIC NUMBER IDENTIFICATION (ANI)--A system capability that enables the automatic display of the seven-digit number of the telephone used to place the 911 call.

BASIC 911 SYSTEM--A telephone system which automatically connects a person dialing the digits "9-1-1" to an established PSAP through normal telephone service facilities.

CALLED PARTY HOLD--A telephone system feature that enables the 911 call answerer to maintain a connection through the telephone system's switching facilities, even if the 911 caller has hung up their telephone.

CALL REFERRAL METHOD--The 911 call answerer at the PSAP provides the calling party with the telephone number of the appropriate agency or organization which is responsible for providing the requested service.

CALL RELAY METHOD--The 911 call is answered at the PSAP (where the pertinent information is gathered) and the call answerer relays the caller's information to an appropriate public safety agency for further action.

CALL TRANSFER METHOD--The PSAP call answerer determines the appropriate responding agency and transfers the 911 caller to that agency.

CENTRAL OFFICE (CO)--Sometimes called a wire center (a switching unit in a telephone system), this is the smallest subdivision within the telephone system which has relatively permanent geographic service boundaries.

CENTRAL OFFICE IDENTIFICATION--When a PSAP serves more than one central office and these central offices all are connected to the PSAP through direct trunks, it is usually possible for a PSAP to identify the central office that forwards each 911 call.

CO--See CENTRAL OFFICE.

CONTRACT SERVICES--Any services which one agency agrees to provide another agency under written contract.

CONTROL OFFICE--Sometimes called a tandem switcher (a Bell System term for the telephone company central office which provides tandem switching capability for selectively routed 911 calls), the control office controls the switching of ANI and selective routing information to the PSAPs and also provides standard ESS Speed Calling features, call-transfer capability and certain maintenance functions for each PSAP.

DATA MANAGEMENT SYSTEM--A system of manual procedures and computer programs used to create, store, and update the data required to provide selectively routed 911 service.

DEFAULT PSAP--See DEFAULT ROUTING.

DEFAULT ROUTING--A selective routing feature which allows 911 calls to be routed to a designated alternate location (default PSAP) if the incoming 911 call cannot be selectively routed due to ANI failure, garbled digits, or other causes which may prevent selective routing.

DIAL TONE FIRST--Sometimes called coin-free dialing or no-coin dial tone, this telephone-system feature enables a caller to dial "9-1-1" or "0" for operator on pay telephones without depositing money.

DIRECT DISPATCH METHOD--911 call-answering and radio-dispatching functions for a particular agency are both performed at the PSAP.

DIRECT PROGRESSIVE CONTROL--A type of telephone switching in which the dialed digits control the electromechanical switches (e.g., Step-by-Step or XY) to activate the connection through the apparatus. The switches used remain connected for the length of the call.

DIRECT TRUNKING--A telephone system design which will assure that a telephone line connection has no intermediate switching points between the originating central office and the PSAP.

DISPATCH CENTER/RADIO DISPATCH CENTER--The location from which a public safety agency's mobile units are dispatched.

DISPATCHER--An individual who uses radio or other means to dispatch a public safety agency's resources. This person also may function as a 911 call answerer.

DISPLAY AND TRANSFER UNIT--A Bell System selector console and associated common equipment that allows display of ANI numbers at the 911 call answerer position, and which is used by the call answerer to activate the fixed transfer and/or selective transfer features.

DMS--See DATA MANAGEMENT SYSTEM.

EAX--(Electronic Automatic Exchange) A central office with programmable telephone switching logic.

EMERGENCY CALL--A telephone request for services which requires immediate action to prevent loss of life, reduce bodily injury, prevent or reduce loss of property, and other emergency situations determined by local custom and policy.

EMERGENCY SERVICE AGENCY--See PUBLIC SAFETY AGENCY.

EMS--Emergency Medical Services.

END OFFICE--The telephone company central office(s) from where the 911 calls originate.

E911--(Enhanced 911) A Bell System term referring to one or a combination of selectively routed 911 service, ANI and ALI, and certain other advanced features.

ESS--(Electronic Switching System) A central office with programmable telephone switching logic.

EXCHANGE--A defined geographical area, served by one or more central offices, in which the telephone company furnishes service.

FIXED TRANSFER--A selective routing feature which allows the call answerer to transfer 911 calls to secondary PSAPs by use of a single button. Each button corresponds to a designated secondary PSAP.

FORCED DISCONNECT--A telephone system feature which allows the PSAP to break or disconnect a telephone connection and thereby avoid caller jamming of 911 lines.

FOREIGN EXCHANGE--A telephone exchange other than one of the exchanges that comprise the 911 system.

FUNCTIONAL SPECIFICATION--A detailed description of system performance requirements.

GRADE OF SERVICE--The probability (usually expressed as a decimal fraction) of a telephone call being blocked by busy lines.

IDLE CIRCUIT TONE APPLICATION--A telephone system feature which applies a distinctive tone to the 911 call answerer to indicate that the calling party has hung up. This tone may indicate whether the calling party has hung up before or after the PSAP answers.

IMPLEMENTATION--Activity between development of functional specifications and commencement of operations.

JOINT POWERS AGREEMENT--An understanding, negotiated between all agencies who will participant in a 911 system, that specifies in writing the role, responsibilities, and benefits of each participating agency.

LEAA--Law Enforcement Assistance Adminstration, U.S. Department of Justice.

MAIN STATION--A telephone that is connected directly to a central office and has a unique telephone number. It is not an extension station.

MANUAL TRANSFER--A selective routing feature which allows the call answerer to transfer an incoming call by pressing a single button and dialing either a telephone number or a two-digit speed calling code.

MULTIBUTTON TELEPHONE SET--An instrument with the capability of multiple line terminations. Each line is accessed by pressing an associated button (key).

MULTIJURISDICTIONAL SYSTEM--A system providing 911 service to more than one political entity.

911 CALL--Any telephone call that is made by dialing the digits "9-1-1".

911 CALL ANSWERER--The initial answerer of a 911 call. This individual may also be a dispatcher.

911 CENTER--(Sometimes called a PSAP) The initial answering location for 911 calls.

911 SYSTEM--A system which automatically connects a telephone, on which the digits "9-1-1" have been dialed, to an established PSAP.

NO-COIN DIALING--See DIAL TONE FIRST.

ONE-STAGE SYSTEM--The same individual(s) at the PSAP both answers 911 calls and functions as a dispatcher.

OPERATING--911 service is in operation and being used by the public.

PBX--(Private Branch Exchange) A private telephone switchboard with many stations not individually identifiable to the telephone company's switching network.

PLANNING--Activity up to and including development of functional specifications.

PREFIX--The first three digits of a seven-digit telephone number.

PRIMARY PSAP--The initial answering location for 911 calls in a selectively routed 911 system. Same as a PSAP in a basic 911 service system.

PRIVATE LINE--A telephone line used only for communication between two points, and which does not connect with the public telephone system.

PSAP--(Public Safety Answering Point) Sometimes called a 911 center; the PSAP is the initial answering location of a 911 call.

PUBLIC AGENCY--Any unit of local, state, or federal government, or special-purpose district which provides or has the authority to provide police, firefighting, medical or other emergency services.

PUBLIC SAFETY AGENCY--A functional division of a public agency which provides police, firefighting, medical or other emergency services.

RINGBACK--A telephone system feature, usually available on circuits equipped with "Called Party Hold," which enables the 911 call answerer to ring the telephone used to place a 911 call immediately after the caller has hung up.

SECONDARY PSAP--A location to which 911 calls are transferred from a PSAP.

SELECTIVE ROUTING--A telephone system feature that enables all 911 calls originating from within a defined geographical region to be answered at a predesignated PSAP.

SELECTIVE TRANSFER--A selective routing feature which allows the call answerer to transfer an incoming call by pressing a single button. There are normally two buttons: one for fire and one for EMS.

SERVING CENTRAL OFFICE--The telephone company central office area in which a PSAP is located.

SR--Selectively routed.

SWITCHHOOK STATUS INDICATION--Allows the PSAP to monitor, by means of supervisory lamps, the status of a calling party being held. Indicates whether the calling party still is connected, is on hold, or has disconnected.

TANDEM TRUNKING--An arrangement where a telephone line connection has one or more intermediate switching points which are required or permitted (usually on a controlled dial pulse basis) before reaching the final destination (called party).

TARIFF--A document filed by a telephone company with the state telephone utility regulatory commission which lists the communication services offered by the company and gives a schedule of rates and charges.

TERMINAL EQUIPMENT--Telephone call answering and transfer equipment.

TTY--Teletypewriter.

TWO-STAGE SYSTEM--The 911 call-answering and the radio-dispatching functions are performed by separate individuals.

WIRE CENTER--See CENTRAL OFFICE.

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Note: The items listed in this bibliography are not available from SRI International. Requests for copies should be directed to:

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