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**National Highway
Traffic Safety
Administration**

Police Personnel Allocation Manual

Sheriffs' Departments

POLICE ALLOCATION MANUAL

Determination of the Number and Allocation of Personnel for
Police Traffic Services for Sheriffs' Departments

- Version S3.0 -

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Prepared by

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FOREWORD

The Police Allocation Manual and Police Allocation Manual User's Guide were developed and field tested by The Traffic Institute of Northwestern University under a contract (No. DTNH22-88-C-05016) issued by the Office of Traffic Safety of the National Highway Traffic Safety Administration, U.S. Department of Transportation. Principal Investigator and author for the study was Dr. William Stenzel. Dr. Stenzel was assisted by Mr. Roy Lucke who had prime responsibility for the design, implementation, and coordination of the field test program. The Contracting Officer's Technical Representative for the project was Mr. David Seiler (The Office of Traffic Safety).

The PAM project was initiated in June 1988. Phases I and II of the project were used to produce a staffing and allocation procedure and manual for use by statewide law enforcement agencies. Phase III was used to modify and field test the initial products of the project for use by sheriffs' departments. Phase I was completed in February 1990. The Phase I field test was conducted during the summer and fall of 1989. Phase II of the project was completed in January 1991 and Phase III will be completed in September 1991.

Several versions or "editions" of the Manual were produced during the project. Version 1.0 was completed in March 1989. Version 2.0 was completed in June 1989 and was used for the Phase I field test. Version 3.0 was completed at the end Phase I (February 1990), Version 3.5 was submitted to NHTSA in January 1991, and Version 4.0 was completed in July 1991. Version S1.0, specifically designed for use by sheriffs' agencies, was produced in December 1990 as part of Phase III of the project. Version S2.0 was completed in February of 1991, and Version S3.0 was submitted in September 1991.

The project team wishes to identify and thank the sheriffs' departments that served as field test sites during Phase III of the study. (The project liaison person for each agency is identified with an "*." The ranks and titles reflect those held during the field test.)

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Polk County (Iowa) Sheriff's Department	Bob E. Rice, Sheriff * Lieutenant David J. Long
Washoe County (Nevada) Sheriff's Department	Vincent G. Swinney, Sheriff * Deputy Carrie Bennett Captain Lee W. Bergevin Sergeant Wes Knight

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A special note of thanks is extended to Ms. Darry Ware whose diligence and persistence helped to insure that project materials were sent to the field test agencies in a timely manner.

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CHAPTER 1: Introduction

Purpose of the Manual

The Police Allocation Manual (PAM) is designed to be used by sheriffs' agencies, or divisions within those agencies, whose mission includes the delivery of police traffic services. The Manual is designed to help such agencies address two key resource allocation questions:

1. What is the total number of officers (i.e., deputies, field supervisors, and staff and command personnel) that are required to provide an acceptable level of service? and

2. How should a specified total number of officers be allocated by geographic regions or time periods to maximize agency productivity?

This version of the Manual is derived from earlier editions that were based on a review of procedures currently used by state and provincial agencies throughout the United States and Canada. The framework and rationale presented in the Manual are the result of a distillation process that identified the "best" procedures, and then modified and blended those procedures into a comprehensive model for determining appropriate staffing levels and deployment patterns.

It is anticipated that the Manual will provide both immediate and long-range benefits. The procedures in PAM will provide agencies with a logical and explicit format in which to frame requests for additional personnel and/or staff allocation. In addition, it is anticipated that the Manual will serve as a catalyst for stimulating further discussion and research in the area of staffing and allocation for law enforcement agencies.

How To Use the Manual

Version S3.0 of the Police Allocation Manual consists of four chapters and two appendixes. Chapter 1 provides a brief introduction to the purposes and uses of the Manual. Chapter 2 describes the PAM staffing and allocation model. Chapter 3 contains eight worksheets, each with instructions, that provide a step-by-step process for determining staffing levels. Chapter 4 contains one worksheet for determining staff allocation over

several geographic areas or time periods. Appendixes A and B contain worksheets that can be used as alternatives or supplements to the procedures presented in sections 5.2 and 5.3 in Chapter 3.

Additional information about the PAM procedures can also be found in the companion document, Police Allocation Manual User's Guide. The Guide presents implementation, data definitions, and data collection strategies used by the field test agencies plus additional reference materials that were contained in earlier versions of the Manual. Also included in the Guide is a summary of key input values and numerical results obtained by the six agencies that field tested the Manual. The appendix materials in the Guide identify the input data required to use the PAM model (Appendix A), present a glossary of key terms and a list of notation used (Appendix B), include a detailed example showing all nine worksheets in completed form (Appendix C), and illustrate the derivation of all formulas used in the model (Appendix D).

For the first-time user of the Manual, the following procedure is recommended:

1. Read Chapter 2 - Chapter 2 can be used to gain an initial understanding of the overall logic of the model and its major components. (The reader may also want to refer to the material in Appendix D in the Guide.) It is not imperative for the user to understand every detail at first reading. The primary objective of Chapter 2 is to provide readers with sufficient information to assess how the model can best be used to assist their agency.

2. Review Appendix A in the User's Guide - Appendix A provides an overview of the types of data that are required to use the PAM model.

3. Review Chapters 3 and 4 - Chapters 3 and 4 contain all the worksheets and instructions for the PAM model. Appendixes B and C in the Guide can be used as references as needed. The purpose of this step is to enhance understanding of the model, to resolve questions about the procedures that are used, and to help the user assess the effort required to use the model.

4. Determine the Data Collection Effort - After reading chapters 2, 3, and 4 (and referring to appendixes A, B, C, and D in the Guide as needed), the user should estimate the data collection effort that will be required to use the model. The following steps are recommended for this assessment:

- Review the sections in the Guide entitled "General Implementation Strategies" (Section 2) and "Recommended Data Collection and Implementation Procedure" (Section 4).

- Review the worksheets in chapters 3 and 4 to identify which model options will be used. (Section 3 in the Guide may also be useful for this step.)

- Compile a list of the input data requirements for the agency. This list will include all the data items in Worksheet 1 plus additional data items from worksheets 2 - 9 depending on the particular options selected. The user may find it more convenient to use Appendix A in the Guide to compile this list.

- For each data item on the list, determine its availability, its accessibility, and the effort that will be required to obtain it. It is important to recognize that no agency is likely to have all the data required; it is probable that every agency will have to estimate some of the data items, at least initially. (Section 3 in the Guide provides specific guidelines and recommendations for collecting a number of key input data items.)

5. Assess the Benefits of the Model to the Agency - Before proceeding further, the user should weigh the benefits to be gained from using the model versus the data collection effort that will be required. This tradeoff can be used to help decide whether to use the model or not.

6. Collect the Required Data - If a decision is made to use the model, initial activities should focus on data collection. The actual time required to collect the data will vary considerably by agency and will depend on the size of the agency, the degree of automation within the records section, and the scope of existing records. Initial data collection efforts may require time that will not be necessary for later uses of the model because some input data items are not likely to change (e.g., the number of roadway miles, the size of the patrol areas, etc.).

7. Complete the Worksheets - Once the input data items have been collected, the nine worksheets in chapters 3 and 4 can be used to determine the staffing and allocation levels required for each patrol area. Once the data are available, actual completion of the worksheets themselves will require relatively little time (i.e., only a few hours) compared to the days or weeks that may be required to collect the data.

8. Review and Adjust the Results - After the model has been used to determine staffing and allocation levels, the results should be carefully reviewed. The purpose of this review is to:

- explicitly identify the rationale for each model option that is used,

- o explicitly identify the rationale for each performance objective value that is used,
- o verify that the agency data used is both comprehensive (e.g., that all patrol workload is accounted for) and consistent with model data definitions, and
- o identify and understand differences between current staffing levels and those specified by the model.

The Role of Resource Allocation Models

It is important for PAM users to remember that the Manual is based on a "model" of staffing and deployment. All models are limited by the assumptions on which they are built and by the data that are used. (See Chapter 2 for additional discussion concerning the limitations of the PAM model.) The user must guard against the temptation to believe that the model provides "the answer." All models, including the one described in the Manual, use a variety of assumptions about the "real" world to assemble data into rational patterns that can be used by decision-makers. (Police administrators do not suffer from a lack of data, but rather from a scarcity of tools for effectively using that data.) The decision-maker, in turn, must weigh the merits of the recommendations of the model against other factors (e.g., political, economic, operational, etc.) in arriving at a final course of action. Perhaps John Schuiteman said it best when he wrote:

> "Adequate police protection, like beauty, lies in the eye of the beholder. The optimal or appropriate ratio of troopers to population, traffic volumes, reported crimes or accidents, etc., is not a matter of mathematics or statistics. It is a matter of human judgment and community resources."
>
> "Allocating State Troopers: The Virginia Experience," The Police Chief, July 1985.

CHAPTER 2: Overview of the Police Allocation Manual Methodology

Time-Based Model

The procedures that are used in the PAM model to determine the total staff requirements for the delivery of police traffic services are based on an analysis of patrol workload requirements, performance objectives, and personnel policies, all measured in time. All deputy time, both on and off-duty, is divided into two categories: patrol and non-patrol. Non-patrol time, determined largely by the personnel policies of the agency, is reflected in the "shift relief factor" determined in Worksheet 8 of the Manual. All patrol time is divided into four time components:

1. Reactive time (calls-for-service),
2. Proactive (self-initiated) time,
3. Proactive (uncommitted patrol) time, and
4. Administrative time.

Reactive Time

Reactive time refers to patrol time spent on activities that can be described as service-on-demand. These are usually calls for service (CFS) that are assigned by radio dispatch. For some agencies, the most important CFS activities are requests for police assistance at traffic accidents. Since most agencies also provide services beyond traffic-related activities, the PAM model classifies all CFS as either "accidents" or "other CFS." The total time spent answering CFS is referred to as "obligated time."

Proactive (Self-Initiated) Time

Proactive (self-initiated) time refers to patrol time spent on non-CFS activities. In the PAM model, self-initiated activities include the issuance of citations and warnings for driving violations, assisting motorists, providing traffic direction and control, and conducting field interrogations.

Proactive (Uncommitted Patrol) Time

Proactive (uncommitted patrol) time refers to the time spent patrolling the roadway system in the jurisdiction (i.e., time not spent on reactive, self-initiated, or administrative activities). Uncommitted patrol provides two benefits: "visibility" for the general deterrence of traffic and criminal violators, and "availability" for self-initiated activities and for the timely response to CFS. Uncommitted patrol time includes time spent on both moving and stationary patrol.

Administrative Time

Administrative time refers to patrol activities that do not fall into the reactive, self-initiated, or uncommitted patrol time categories. Typical administrative activities include on-duty court time, personal time (e.g., for meals), patrol car maintenance, training, and agency administrative duties. On-duty time spent on non-patrol activities such as extended training or special assignments are accounted for in the calculation of the shift relief factor for the agency.

Autonomous Patrol Areas

The PAM procedures are designed to determine total staffing requirements for "autonomous patrol areas"; that is, geographic areas that exhibit the following characteristics:

- virtually all of the CFS that originate in the area are handled by deputies assigned to the area (or conversely, few CFS in the area are handled by deputies assigned to other areas);
- deputies assigned to the area are rarely assigned to CFS outside of the area; and
- although deputies may be assigned to specific geographic subdivisions within the area for patrol, a deputy may be dispatched, if required, to a CFS anywhere within the area.

In some agencies, each district or zone operates as an autonomous patrol area (APA). In others, with larger geographic areas, one district may consist of several APAs. In some cases, the entire county may serve as a single APA.

Total Staff Requirements

To determine the total staff requirement for an agency, the PAM model is used in the following way:

1. The entire jurisdiction is used as single autonomous patrol area (APA) or is subdivided into a number of autonomous patrol areas (APAs). The APAs should cover the entire jurisdiction and should not overlap one another.

2. The PAM procedures are used to determine the total staffing requirement for each APA.

3. The staffing requirement for the entire jurisdiction is obtained by adding the staffing numbers for all the APAs. (The resulting total may need to be supplemented with additional personnel assigned to the central or regional headquarters of the agency.)

The PAM model uses the following steps to determine the total staffing requirement for each APA:

1. Determine the average daily on-duty staff requirement (i.e., the number of deputies required to meet the administrative, reactive, self-initiated, and uncommitted patrol requirements). The resulting number of deputies is then adjusted for the use of two-officer patrol units, specialized units, and, if applicable, minimum staffing requirements.

2. Determine the average number of on-duty field supervisors required to support the average daily on-duty deputy requirement. The number of deputies is then adjusted to account for patrol workload performed by field supervisors.

3. Determine the total staff requirement (i.e., the total number of personnel needed, both on and off-duty, to support the required on-duty patrol presence) for the APA. The total staff requirement will include deputies, field supervisors, and staff and command personnel.

Average Daily On-Duty Deputy Requirement

The PAM model determines the average number of on-duty deputies that will be required each day (i.e., within each 24-hour period) based on the following formula (see Appendix D in the Guide for a derivation of this formula):

$$N = \frac{N_r + N_p}{1 - \frac{m_a}{60} - \frac{m_s}{60}}$$

where:

- **N** - the average number of on-duty deputies required per day (i.e., per 24-hour period),
- $\mathbf{N_r}$ - the average number of on-duty deputies required per day to service all CFS and accidents in the APA,
- $\mathbf{N_p}$ - the average number of on-duty deputies required per day to provide the specified level of uncommitted patrol in the APA,
- 1 - a constant,
- $\mathbf{m_a}$ - the average number of minutes per hour spent on administrative activities by each on-duty deputy,
- $\mathbf{m_s}$ - the average number of minutes per hour spent on self-initiated activities by each on-duty deputy, and
- 60 - a constant.

Much of the effort required to use the PAM model is spent determining appropriate values for $\mathbf{N_r}$, $\mathbf{N_p}$, $\mathbf{m_s}$, and $\mathbf{m_a}$ based on the workload level, operational policies, and roadway and traffic characteristics of the agency and patrol area. The basis for deriving each of these values is outlined below.

Number of deputies for reactive time workload ($\mathbf{N_r}$). The average number of deputies required per day to provide service for all accidents and other CFS in the patrol area is based on the average total obligated time per day required for all accidents and other CFS, and the shift length used by the agency.

Number of deputies for uncommitted patrol time ($\mathbf{N_p}$). The average number of deputies required per day to provide uncommitted patrol is based on:

- o the number of deputies required to provide an adequate level of uncommitted patrol visibility as measured by the "patrol interval" (i.e., the average time between trips past any given point on the roadway); and

- the number of deputies required to insure a timely response to obligated time activities.

The number of deputies required for visibility is based on the miles of roadway to be patrolled, the hours of coverage per week, the average uncommitted patrol speed, the shift length, and the desired patrol interval by roadway type. As an example, a patrol interval of eight hours indicates that a deputy will be observed on uncommitted patrol on a given roadway segment about once every eight hours or three times per day.

Two criteria are available in the PAM model for determining the number of deputies required for a timely response to CFS. The number can be determined based on either:

- the percent of obligated time activities for which a deputy is immediately "available" (i.e., a deputy not currently involved in a CFS, self-initiated, or administrative activity), or

- the average travel time to each obligated time activity.

The number of deputies required for immediate response is based on the average number of deputies required per shift for reactive time activities and the immediate response percent set by the agency. Travel time values are based on the size of the patrol area (and/or roadway miles if line patrol is used), the hours of coverage per week, the average response speed, the shift length, and the average travel time objective set by the agency.

Self-initiated time per hour per deputy (m_s). The PAM model does not attempt to directly determine the total number of deputies that are necessary for all self-initiated activities. To produce such a value would require an accurate measure of the total self-initiated workload for the agency (i.e., the total time that an agency should spend on these activities within the patrol area). To avoid the difficulties associated with determining this value, the PAM model focuses on the number of minutes per hour spent on self-initiated activities by each deputy(m_s). The PAM model allows the user either to specify a value for m_s or to derive a value based on self-initiated data for the agency from previous years.

Administrative time per hour per deputy (m_a). Paralleling the rationale given above for determining m_s, the PAM model does not attempt to determine the total administrative workload of the patrol force, but rather focuses on the amount of administrative time required per hour per deputy (m_a). The PAM model permits the user either to specify a value for m_a or to estimate it based on agency experience.

Adjustments to the Average Daily Number of On-Duty Deputies

The initial value for the average number of on-duty deputies required per day is examined to determine whether additional or fewer deputies are needed because of:

- the use of two-deputy patrol units,
- patrol provided by deputies assigned to specialized units (e.g., hazardous materials or accident investigations), and
- minimum staffing levels.

Average Daily Number of On-Duty Field Supervisors

The average number of on-duty deputies required per day serves as the basis for calculating the number of on-duty field supervisors required. Two factors are used to determine the final number of on-duty deputies and supervisors:

(1) the average number of deputies supervised by each field supervisor (set by agency policy), and

(2) the fraction of each field supervisor's time spent on patrol (i.e., non-supervisory) activities.

Total Staff Requirements

Worksheet 8 of the PAM model is used to determine the total number of personnel, both on- and off-duty, required to support the average number of on-duty deputies and field supervisors required per day. The total number of personnel consists of deputies, field supervisors, and staff and command personnel. The total number of deputies and field supervisors is determined using the shift relief factor for the agency. This factor indicates the average number of officers required to staff one shift position every day, and is based on the shift length, the average work week, and the average number of on-duty patrol hours expected from each officer per year. The number of staff and command personnel required is specified as a policy decision by the user.

Total Staff Allocation

The final worksheet in the Manual (Worksheet 9 in Chapter 4) is used to determine staff allocation over several geographic areas based on the PAM staffing estimates for each APA and the total number of staff personnel available for deployment. Although the discussion in this section and Chapter 4 refers only

to the allocation of staff over several APAs (i.e., allocation over geographic areas), the logic of the procedure can be applied equally well for allocation over time periods (e.g., staff allocation over shifts or days of the week). To use Worksheet 9 for allocation over different time periods, however, requires that PAM staffing estimates be obtained for each time period of interest.

Worksheet 9 can be used to determine two kinds of allocations.

Unconstrained Allocation

Unconstrained allocation refers to a redistribution of all available staff among several APAs according to the percentage of staff in each APA based on staff estimates from the PAM model. Such an allocation is called "unconstrained" because it is possible that a reallocation of the total staff may produce a deployment in which some APAs gain staff and other APAs lose staff.

Constrained Allocation

Constrained allocation refers to a reallocation of staff under the following limitations:

- o if the total staff is to be increased, no APA will lose staff because of the reallocation, or
- o if the total staff is to be decreased, no APA will gain staff because of the reallocation.

The process for determining the allocation under these limitations consists of the following steps:

1. The results of the unconstrained allocation are used to characterize each APA as either overstaffed or understaffed.

2a. If the total staff is to be increased, the additional staff (i.e., the difference between the current total staff and the final total staff) are allocated, based on the PAM staffing estimates for each APA, only to those APAs that are currently understaffed; (Staffing levels for overstaffed APAs remain unchanged.) or

2b. If the total staff is to be decreased, the staff reduction (i.e., the difference between the current total staff and the final total staff) is allocated, based on the PAM staffing estimates for each APA, only to those APAs that are currently overstaffed. (Staffing levels for understaffed APAs remain unchanged.)

It is possible under the limitations of constrained allocation that, even after reallocation, some APAs may still be over or understaffed.

Limitations of the PAM Model

The PAM model, as presented in this document, should be viewed as a generic procedure that must be adapted to fit the mission, physical environment, roadway system, and operational idiosyncrasies of each agency. Sheriffs' departments in the United States exhibit a wide range of missions: from full-service police agencies to departments with limited responsibilities. The varieties of agency missions, in turn, exist within a wide range of environmental and roadway settings.

In addition, there are a number of issues which, although addressed in a general sense in the PAM model, represent relationships and circumstances for which additional research and operational experience are needed. Some of these areas include:

- the impact of state and municipal law enforcement agencies upon the mission and resource requirements of sheriffs' agencies;
- the relationship between the amount of self-initiated work and various roadway and traffic characteristics;
- the determination of travel time for large non-urban areas with sparse roadway systems; and
- the determination of staffing requirements for high-volume, high-density, urban interstate and expressway systems.

CHAPTER 3: PAM Instructions and Worksheets for Determining Total Staff Requirements

Introduction

This chapter provides a systematic format and process for determining the total staff requirements for sheriffs' agencies providing police traffic services in autonomous patrol areas. The process is presented in a series of eight worksheets entitled:

Worksheet 1: Operations, Workload, and Roadway Data

Worksheet 2: Administrative Time

Worksheet 3: Reactive Time

Worksheet 4: Proactive Time - Self-initiated

Worksheet 5: Proactive Time - Uncommitted Patrol

Worksheet 6: Average Daily Number of On-Duty Deputies

Worksheet 7: Special Assignments and Field Supervision

Worksheet 8: Total Staff Requirements

Worksheet Format

The same format for each data entry and calculation step is used in all eight worksheets. Each worksheet is divided into a number of sections. The beginning and end of each section are identified with a double line. Each section, in turn, consists of a series of individual steps. For each step, a numeric value is obtained and recorded in a box on the right-hand side of the worksheet. Each box is labeled with a numeric identifier to facilitate reference to values that are used in later steps, sections, or worksheets. The numeric value that is recorded for each step is obtained in one of four ways:

- o data collection,
- o policy decision,
- o referenced from an earlier step, or

- o calculated using the method or formula given in the worksheet based on numeric quantities from previous steps.

Two methods are used to highlight important results:

1. The box is drawn with double lines, and/or

2. A letter notation, shown in parentheses to the right of the box, is used to identify the result.

Preceding each worksheet is a brief description of its purpose followed by instructions for individual steps and the anticipated source of required data items; that is: data collection (D), policy decision or current agency practice (P), referenced value (R), or calculation (C).

For some procedures, more than one method is available for obtaining a particular data item. When two or more options are presented, they are separated by a pair of horizontal lines with the word "OR" between them.

Terminology, Notation, and Key Assumptions

Appendix B in the Guide presents definitions for key terms that are used in the PAM instructions and worksheets. The appendix also lists and identifies all abbreviations and notations that are used in the worksheet formulas.

Within the Manual, the term "patrol" refers to the activities associated with all four time categories used in the PAM model (i.e., reactive, self-initiated, administrative, and uncommitted). "Non-patrol" refers either to off-duty time or to on-duty time spent on temporary special assignments that do not include activities in any of the four time categories. (A more detailed discussion of non-patrol time is presented in the instructions for Worksheet 1.) The term "uncommitted patrol" refers to one of the four time categories and represents patrol time spent in the field while not engaged in reactive, self-initiated, or administrative activities. This definition of patrol is sometimes referred to as "preventive patrol" or "uncommitted time." The total uncommitted patrol time per hour equals the time left over when the average number of minutes per hour spent on reactive, self-initiated, and administrative activities is subtracted from 60 minutes. The appropriate meaning of "patrol" in the Manual is indicated by the context in which it is used.

The PAM model is based on a number of assumptions that are identified in the instructions preceding each worksheet. Two key assumptions that should be kept in mind are:

1. The total staff requirement determined with the worksheets is <u>only applicable to autonomous patrol areas (APA)</u>. If a district or zone consists of more than one APA, the total staffing requirement for the district or zone is obtained by determining the staffing requirement for <u>each APA</u> and adding the results together.

2. The procedures used in worksheets 1-5 and Section 6.1 of Worksheet 6 assume the use of only one deputy for each patrol unit. As a result, the phrases "number of deputies" and "number of patrol units" are used interchangeably. An adjustment for the use of two-deputy patrol units is presented in Section 6.2 in Worksheet 6.

Instructions for Worksheet 1: Operations, Workload, and Roadway Data

Worksheet 1 is used to identify most of the data items that will be used in worksheets 2 - 8. Worksheet 1 is not a complete list of all the data items that may be needed since several of the worksheets permit the use of optional procedures, each requiring a slightly different set of data items. (A complete list of all input data items is presented in Appendix A in the Guide.)

Some procedures in the worksheets use the number of roadway miles in the APA as part of the calculation process. The worksheets in this version of the Manual are designed to accommodate up to three categories or types of roadways. (More than three can be easily accommodated if necessary). Each PAM user is free to determine how many types will be used and what the definition of each category will be. How many types to use and what the definition of each should be is related to the variety and extent of roadways in an APA and the nature of the data collection system used by the agency. Possible roadway categories that can be used are controlled-access, U.S. highway, expressway, freeway, state highway, primary roadway, secondary roadway, rural roadway, municipal, and residential streets. Definitions for some roadway categories are provided in Appendix B in the Guide.

Regardless of how many roadway types and what definitions are used, all roadways in the APA regularly patrolled by the agency must be included in one of the roadway types.

Instructions for Individual Steps

1.1 Name of the autonomous patrol area (usually a district, zone, or county) (D).

1.2 Operations Data for the APA

1.2.1 Shift length is the number of hours each deputy is on duty for one tour or watch or shift (P). If shift length varies by deputy or assignment, an average value should be used.

1.2.2 The average number of on-duty hours on patrol per year per deputy refers to the actual number of hours that a deputy appears for regular patrol duty each year (D). This number should include both regularly scheduled on-duty time and paid overtime. (See discussion below about "non-patrol" time.)

The average number of actual on-duty hours spent on patrol may be determined in a number of ways. The agency may have a system that keeps track of the number of on-duty patrol hours for each deputy. If this system is used, the average number of hours is obtained by adding all the on-duty patrol hours and dividing by the number of deputies. In some agencies, it may be easier to determine the average on-duty hours per year on patrol per deputy by assuming that each deputy works one shift on patrol every day and then subtracting the average number of non-patrol hours, both on and off-duty, per year per deputy.

"Non-patrol" time consists of:

(1) regular days off - unpaid time off. The number of regularly-scheduled days off is determined by the shift length and the average work week (e.g., an 8-hour shift length and a 40-hour work week produces an average of 2 days off per week).

(2) benefit days off - paid days off. Benefit days off usually include vacation leave, sick leave, holiday leave, compensatory time off, and a variety of other kinds of days off that vary by agency and region.

(3) temporary special assignments - on-duty assignments that remove an officer from patrol operations (e.g., attendance at a training course, assignment to duty at the county fair, limited duty status, etc.). It is recommended that only assignments that last one or more shifts at a time be included in this category. Activities that require less than one shift (e.g., roll-call training and desk duty for one or two hours) should be included as administrative time when estimating $\mathbf{m_a}$ in Worksheet 2.

1.2.2.1 Average work week (P).
The average number of hours an officer is paid for each week. Most agencies use 40 hours a week, although it is not uncommon to find values that are slightly above or below this value.

1.2.2.2 Average number of benefit hours off per year per officer (P).

The average number of paid off-duty hours an officer uses per year for vacation, holidays, illness, compensatory time off, etc. It is important to note that this value is benefit time taken which may be less than benefit time earned per year. Since this value reflects the specific benefit time-off policies and experience of an agency, it can only be estimated by collecting data on the benefit time-off history of the agency.

1.2.2.3 Average number of on-duty hours spent on temporary (non-patrol) special assignments per year per officer.

Paid on-duty time that is not spent on regular patrol operations.

1.2.3 Average number of deputies to be supervised by one field supervisor (P).

1.2.4 Percent of field supervisor on-duty time spent on patrol activities (D).

"Patrol activity" refers to any activity that would be performed by a deputy if the field supervisor was not present. Alternatively, patrol activities for field supervisors can be thought of as all non-supervisory activities. The percentage is a number between 0 and 100. A value of 0 indicates that each field supervisor spends no (zero) time on patrol activities. A value of 50 indicates that each field supervisor spends an average of 50% of his/her time on patrol activities.

1.2.5 Patrol operations - roadway category 1

1.2.5.1 Name or type of roadway used for category 1.

1.2.5.2 Coverage per week (P)(D).

The number of hours that category 1 roadways in the patrol area are covered per week. A roadway is considered "covered" during a shift if at least one deputy has patrol responsibility for the roadway. Note that a "covered" roadway does not imply that the patrol level is adequate; merely that at least one unit has patrol responsibility for it whether it can provide adequate coverage or not.

Coverage is expressed in hours per week (i.e., a number between 0 hours (no coverage) and 168 hours (coverage 24 hours per day, seven days a week). Coverage in shifts per week can be easily converted to hours; e.g.,

Patrol Coverage, Number of 8-Hours Shifts per Week	Patrol Coverage, Number of Hours Per Week
21	168
14	112
5	40

If coverage varies by roadway location, determine an overall average level of coverage based on the following formula (assuming three coverage levels):

$$\text{Average Coverage (hrs/wk)} = \frac{H_1 \times M_1 + H_2 \times M_2 + H_3 \times M_3}{M_1 + M_2 + M_3}$$

where:

H_1, H_2, H_3 - Hours of coverage for segments 1, 2, and 3.

M_1, M_2, M_3 - Miles of segments 1, 2, and 3.

1.2.5.3 Average patrol speed (D).

The average speed (MPH) of units while on "uncommitted patrol" on category 1 roadways (i.e., it does not include the average speed during travel to an accident or other CFS or travel while performing administrative or self-initiated activities <u>or</u> while on uncommitted patrol on non-category 1 roadways). This value can be determined by dividing the miles driven while on uncommitted patrol (on category 1 roadways) per shift by the time spent on uncom-

mitted patrol (on category 1 roadways) during the shift. The uncommitted patrol time spent on a particular roadway type equals the shift length minus time spent on accidents, other CFS, self-initiated, administrative activities, and uncommitted time spent on other roadway types. Note that uncommitted patrol time includes time spent on both stationary and moving patrol even when speeds are reduced because of traffic volumes or control devices.

1.2.5.4 Patrol interval performance objective (P).

The patrol interval indicates the frequency with which a deputy will pass a given point on a category 1 roadway. Measured in hours, it is the average time a stranded motorist would have to wait for a deputy to come by on uncommitted patrol. As the patrol interval objective is lowered, the number of deputies required increases. As examples, consider the table below (based on 8-hour shifts):

Patrol Interval (hours)	Patrol Frequency (times past fixed location)
2	4 times per shift
4	2 times per shift
8	once a shift
24	once per day
168	once per week

Note that "patrol interval" and "patrol coverage" are not directly related. Patrol coverage merely indicates responsibility for patrolling a roadway segment. The patrol interval determines the extent or intensity of the coverage.

1.2.6 Patrol operations - roadway category 2

See instructions for steps 1.2.5.1 - 1.2.5.4.

1.2.7 Patrol operations - roadways category 3

See instructions for steps 1.2.5.1 - 1.2.5.4.

1.3 Workload Data for the APA

1.3.1 Total number of days in the sample period (D).

Collect accident and other CFS data for the previous 1, 2, or 3 years.

1.3.2 Total number of accidents during the sample period (D).

Total number of accidents handled or investigated by the agency during the sample period. The number should include accidents in which the agency only provides backup services.

1.3.3 Average service time (hours) per accident (D).

The average time required to handle one accident. The average time can be determined on the basis of a sample of 100 or more accidents. The average service time for an accident includes:

- travel time to the accident,
- on-scene time,
- report writing time,
- follow-up investigation time, and
- time charged by all agency units assigned to the accident.

Note that the average service time for accidents does <u>not</u> include dispatching time.

1.3.4 Total number of other CFS during the sample period (D).

Total number of other CFS handled by the agency during the sample period. The number should include CFS for which the agency only provides backup support.

1.3.5 Average service time (hours) per other CFS (D).

The average time required to process one CFS. The average time can be determined on the basis of a sample of 100 or more other CFS. The average service time for a CFS includes:

- travel time to the CFS,
- on-scene time,
- report writing time,

- follow-up investigation time, and
- time charged by all agency units assigned to the CFS.

Note that the average service time for other CFS does <u>not</u> include dispatching time.

1.4 Roadway Data for the APA

For steps 1.4.1 - 1.4.3, enter the number of miles in the patrol area for category 1, 2, and 3 type roadways based on the roadway category definitions determined by the agency.

The total miles determined should be based on roadways in the jurisdiction of the agency that are routinely patrolled by agency personnel. Roadway miles within a municipality that are considered within the jurisdiction of a sheriff's agency, but are not usually patrolled by deputies would not be included.

Note that if visibility or access to opposing lanes is limited (e.g., on some interstate roadways and urban expressways), each direction of travel can be considered as a separate roadway in determining total length.

WORKSHEET 1: Operations, Workload, and Roadway Data

Objective: Identify data items to be used for determining the number of patrol personnel within an APA.

Method: Data is identified as either operations, workload, or roadway.

1.1 Autonomous Patrol Area Name . . [ ] (1.1)

1.2 Operations Data for the APA

1.2.1 Shift length (hours) . . . . . [ ] (1.2.1)

1.2.2 Average number of on-duty hours on patrol per year per officer

1.2.2.1 Average work week (average number of paid hours per per week per officer) . . . [ ] (1.2.2.1)

1.2.2.2 Average number of benefit (paid) off-duty hours per year per officer . . . . . [ ] (1.2.2.2)

1.2.2.3 Average number of on-duty hours spent on non-patrol temporary assignments per year per officer . . . .

(1.2.2.3)

1.2.3 Average number of deputies to be supervised by each field supervisor . . . . . .

(1.2.3)

1.2.4 Percentage of field supervisor on-duty time spent on uncommitted patrol, reactive, and self-initiated activities . . . . . .

(1.2.4)

1.2.5 Patrol operations - roadway category 1

1.2.5.1 Category 1 roadway type . .

(1.2.5.1)

1.2.5.2 Coverage per week (hours), (maximum value = 168) . . .

(1.2.5.2)

1.2.5.3 Average uncommitted patrol speed (MPH) . . . .

(1.2.5.3)

1.2.5.4 Patrol interval performance objective (hours) . . . . . .

(1.2.5.4)

1.2.6 Patrol operations - roadway category 2

1.2.6.1 Category 2 roadway type . .

(1.2.6.1)

1.2.6.2 Coverage per week (hours), (maximum value = 168) . . .

(1.2.6.2)

1.2.6.3 Average uncommitted patrol speed (MPH) . . . .

(1.2.6.3)

1.2.6.4 Patrol interval performance objective (hours) . . . . . .

(1.2.6.4)

1.2.7 Patrol operations - roadway category 3

1.2.7.1 Category 3 roadway type . .

(1.2.7.1)

1.2.7.2 Coverage per week (hours), (maximum value = 168) . . .

(1.2.7.2)

1.2.7.3 Average uncommitted patrol speed (MPH) . . . .

(1.2.7.3)

1.2.7.4 Patrol interval performance objective (hours) . . . . . .

(1.2.7.4)

1.3 Workload Data for the APA

1.3.1 Total number of days in the sample period . . . . . .

(1.3.1)

1.3.2 Total number of accidents handled by the agency during the sample period . . . . . .

(1.3.2)

1.3.3 Average service time (hours) per accident . . . . . .

(1.3.3)

1.3.4 Total number of other CFS handled by the agency during the sample period . . . . . .

(1.3.4)

1.3.5 Average service time (hours) per other CFS . . . . . .

(1.3.5)

1.4 Roadway Data for the APA

1.4.1 Roadway category 1 (miles) . . . .

(1.4.1)

1.4.2 Roadway category 2 (miles) . . . .

(1.4.2)

1.4.3 Roadway category 3 (miles) . . . .

(1.4.3)

Instructions for Worksheet 2: Administrative Time

Worksheet 2 is used to determine the average number of minutes per hour per deputy spent on administrative activities (e.g., on-duty court time, range training, etc.). Either of two procedures can be used to obtain a value for the administrative time ($\mathbf{m_a}$). In Section 2.1, the user specifies the value directly. In Section 2.2, the user determines the value based on agency administrative workload information for the APA. Care must be taken in defining what agency activities will be included as administrative time to insure that all non-patrol time is included and that no activities are counted more than once. (See the instructions for operations data in Worksheet 1 above and Section 3 in the Guide.)

Instruction for Individual Steps

2.1 User specifies average number of minutes per hour per deputy spent on administrative time (P).

2.2 Determine $\mathbf{m_a}$ based on the historical experience of the agency within the APA (D).

2.2.1 Select a sample period (e.g., one year) and collect data that indicates the total amount of time (hours) spent by the patrol force on administrative activities during the sample period within the APA.

2.2.2 Determine the total number of on-duty hours on patrol provided in the APA during the sample period used for Step 2.2.1.

2.3 Administrative Time

User selects a value for $\mathbf{m_a}$ based on either section 2.1 or 2.2.

Note that the value selected for $\mathbf{m_a}$ (Step 2.3) must satisfy the following condition:

$$0 \leq m_a < 60.$$

This condition requires that the total administrative time per hour for administrative activities must be greater than or equal to zero minutes and less than 60 minutes. In practice, administrative time per deputy is usually less than 20 minutes per hour.

WORKSHEET 2: Administrative Time

Objective: Determine the average number of minutes per hour per deputy to be spent on administrative activities within the APA (m_a).

Method: Based either on policy decision or historical experience.

OPTION: Complete Section 2.1 or Section 2.2.

2.1 Average Number of Minutes Per Hour Per Deputy - Policy Decision

Select administrative time performance objective in minutes per hour per deputy . . . . . [ ] (2.1)

Continue with Section 2.3.

OR

2.2 Average Number of Minutes Per Hour Per Deputy - Historical Experience

2.2.1 Total time (hours) spent on administrative activities within the APA during the sample period . [ ] (2.2.1)

2.2.2 Total on-duty hours on patrol within the APA during the sample period . . . . . [ ] (2.2.2)

2.2.3 Fraction of time spent on administrative activities, divide: (2.2.1) ÷ (2.2.2) . . . . [ ] (2.2.3)

2.2.4 Average number of minutes per hour per deputy, multiply: (2.2.3) x 60 . . . . . [ ] (2.2.4)

2.3 Administrative Time

Minutes per hour per deputy, select either (2.1) or (2.2.4) . . . . . [ ] (m_a) (2.3)
(note: $0 \leq m_a < 60$)

Instructions for Worksheet 3: Reactive Time

Worksheet 3 is used to determine the average number of on-duty deputies (N_r) that are needed each day to handle accidents and other CFS within an APA. The average number of on-duty deputies required per day is determined with the formula:

$$N_r = \frac{\text{Average Total Obligated Time (hours) Per Day For Accidents and Other CFS}}{\text{Shift Length (hours)}}$$

Derivation of this formula is presented in Section D.1 in Appendix D in the Guide.

Sections 3.1 and 3.2 are used to determine the average obligated time per day for accidents and other CFS respectively. If desired, the "other CFS" category can be divided into subcategories (e.g., other agency assists, criminal calls, etc.) for informational purposes. The total average obligated time per day is obtained in Step 3.3.1, and the number of on-duty deputies is calculated in Step 3.3.3.

Agencies that are using computer-aided dispatching (CAD) systems may be able to obtain the total obligated time data required for steps 3.1.3 and 3.2.3 directly. Agencies that use this approach should insure that the total time reported by the CAD system includes all of the elements of obligated time; i.e.,

- travel time to the scene,
- on-scene time,
- report writing time,
- follow-up investigation time, and
- time consumed by all units involved with the incident.

WORKSHEET 3: Reactive Time

Objective: Determine the number of deputies required to handle accidents and other CFS within an APA (N_r).

Method: Based on the total time required to handle all accidents and other CFS, and the shift length.

3.1 Daily Service Time Requirement for Accidents

3.1.1 Total number of accidents within the APA during the sample period, use (1.3.2) . . . . [ ] (3.1.1)

3.1.2 Average service time (hours) for each accident, use (1.3.3) . . [ ] (3.1.2)

3.1.3 Total obligated time for accidents within the APA during the sample period, multiply: (3.1.1) x (3.1.2) . . . (or enter directly from CAD system) [ ] (3.1.3)

3.1.4 Total number of days in the sample period, use (1.3.1) . . . . [ ] (3.1.4)

3.1.5 Average workload per day for accidents (hours), divide: (3.1.3) ÷ (3.1.4) . . . . . [ ] (3.1.5)

3.2 Daily Service Time Requirement for Other CFS

3.2.1 Total number of other CFS within the APA during the sample period, use (1.3.4) . . . . [ ] (3.2.1)

3.2.2 Average service time (hours) for each CFS, use (1.3.5) . . . . [ ] (3.2.2)

3.2.3 Total obligated time for other CFS within the APA during the sample period, multiply: (3.2.1) x (3.2.2) . . . (or enter directly from CAD system) [ ] (3.2.3)

3.2.4 Total number of days in the sample period, use (1.3.1) . . . . [ ] (3.2.4)

3.2.5 Average workload per day for other CFS (hours), divide: (3.2.3) ÷ (3.2.4) . . . . . [ ] (3.2.5)

3.3 Total Number of Deputies Required per Day for Reactive Time

3.3.1 Total average workload per day within the APA (hours), add: (3.1.5) + (3.2.5) . . . . . [ ] (3.3.1)

3.3.2 Shift length (hours), use (1.2.1) . . . . . [ ] (3.3.2)

3.3.3 Average number of on-duty deputies required per day within the APA to meet the average daily workload, divide: (3.3.1) ÷ (3.3.2) . . . . . [ ] (N_r) (3.3.3)

Instructions for Worksheet 4: Proactive Time - Self-initiated

Worksheet 4 is used to determine the average number of minutes per hour (m_s) each deputy spends on self-initiated activities within the APA. Three alternative procedures are available to determine m_s. The user can either:

(1) select the value directly based on agency policy (Section 4.1),

(2) determine the value indirectly by specifying a number of self-initiated contacts per shift per deputy, the shift length of the agency, and the average time per contact (based on agency experience within the APA) (Section 4.2), or

(3) determine the value based on agency workload experience within the APA (Section 4.3).

Instructions for Individual Steps

4.1 User selects the average number of minutes per hour per deputy to be spent on self-initiated activities within the APA (P).

4.2 User selects m_s based on a performance objective for the average number of self-initiated contacts (i.e., warnings, citations, assists, etc.) per shift, the agency shift length, and the average time per contact within the APA (P) (D).

4.2.1 Collect data to determine the total number of self-initiated contacts within the APA during a specified sample period (e.g., one year).

4.2.2 Determine the total time (hours) spent on self-initiated activities by the patrol force within the APA during the same sample period used for Step 4.2.1.

4.3 Determine m_s based on agency experience within the APA (D).

4.3.1 Determine the total time (hours) spent on self-initiated activities within the APA during a sample period (e.g., one year). Note: the total hours indicate the time actually spent handling self-initiated activities; i.e., issuing violations, assisting disabled

motorists, etc. It does not include the time spent in looking for these activities.

4.3.2 Determine the total on-duty hours on patrol within the APA during the sample period used for Step 4.3.1.

4.4 Proactive Time (Self-initiated)

User selects a value for $\mathbf{m_s}$ based on either section 4.1, 4.2, or 4.3.

Note that the values selected for $\mathbf{m_a}$ (Section 2.3) and $\mathbf{m_s}$ (Section 4.4) must satisfy the following conditions:

$$0 \leq m_a < 60,$$

$$0 \leq m_s < 60, \text{ and}$$

$$0 \leq m_a + m_s < 60.$$

These conditions require that the total time per hour for administrative activities, self-initiated activities, and for administrative and self-initiated activities combined must be greater than or equal to zero minutes and must be less than 60 minutes. In practice, self-initiated time per hour is usually less than 15 minutes.

The PAM field test results suggest that the combined times for administrative and self-initiated activities (i.e., $\mathbf{m_a} + \mathbf{m_s}$) for most agencies falls in the range: 15 - 30 minutes per hour; i.e.,

$$15 \leq m_a + m_s \leq 30.$$

It should be noted that the general structure of the PAM model is predicated on the assumption that administrative and self-initiated activities together do not consume a majority of available patrol time (i.e., that $\mathbf{m_a} + \mathbf{m_s} \leq 30$ minutes). The use of a combined time for administrative and self-initiated activities that is greater than 30 minutes is not recommended.

WORKSHEET 4: Proactive Time - Self-initiated

Objective: Determine the average number of minutes per hour per deputy to be spent on self-initiated activities within the APA (m_s).

Method: Based either on policy decision or historical experience within the APA.

OPTION: Complete Section 4.1 or Section 4.2 or Section 4.3.

4.1 Average Number of Minutes Per Hour Per Deputy - Policy Decision (Direct)

Select self-initiated performance objective for the APA, minutes per hour per deputy . . . . . [ ] (4.1)

Continue with Section 4.4

OR

4.2 Average Number of Minutes Per Hour Per Deputy - Policy Decision (Indirect)

4.2.1 Total number of self-initiated contacts within the APA during the sample period . . . . . [ ] (4.2.1)

4.2.2 Total time (hours) spent on self-initiated contacts within the APA by all deputies on patrol during the sample period . [ ] (4.2.2)

4.2.3 Average time (hours) per self-initiated contact within the APA during the sample period, divide: (4.2.2) ÷ (4.2.1) . . . . [ ] (4.2.3)

4.2.4 Select number of self-initiated contacts <u>per shift</u> per deputy performance objective . . . . . [ ] (4.2.4)

4.2.5 Shift length (hours), use (1.2.1) . . . . . [ ] (4.2.5)

4.2.6 Number of self-initiated contacts per hour per deputy, divide: (4.2.4) ÷ (4.2.5) . . . . [ ] (4.2.6)

4.2.7 Self-initiated performance objective for the APA in minutes per hour per deputy, multiply: 60 x (4.2.3) x (4.2.6) . . . . . [ ] (4.2.7)

Continue with Section 4.4

OR

4.3 Average Number of Minutes Per Hour Per Deputy - Historical Experience

4.3.1 Total time (hours) spent on self-initiated contacts within the APA by all deputies on patrol during the sample period, (same as (4.2.2)) . . . . . [ ] (4.3.1)

4.3.2 Total on-duty hours by deputies on patrol within the APA during the sample period, (same as (2.2.2)) . . . . . [ ] (4.3.2)

4.3.3 Fraction of time spent on self-initiated activities within the APA during the sample period, divide: (4.3.1) ÷ (4.3.2) . . . . . [ ] (4.3.3)

4.3.4 Average number of minutes per hour per deputy to be spent on self-initiated activities within the APA, multiply: 60 x (4.3.3) . . [ ] (4.3.4)

4.4 Proactive Time (Self-initiated)

Minutes per hour per deputy, select either (4.1) or (4.2.7) or (4.3.4) (note: $0 \leq m_s < 60$) . . . . . [ ] (m_s) (4.4)

Instructions for Worksheet 5: Proactive Time - Uncommitted Patrol

Worksheet 5 is used to determine the number of deputies (N_p) that are required for an adequate level of uncommitted patrol to provide visibility for general deterrence and availability for the timely response to accidents and other CFS within the APA.

Section 5.1 is used to determine the number of deputies that are required to meet the patrol interval level specified by the user for each roadway type within the APA. The formula for the number of deputies (used in steps 5.1.2.6, 5.1.3.6, and 5.1.4.6) is based on:

- o the number of roadway miles,
- o the hours of patrol coverage per week,
- o the average patrol speed (MPH),
- o the shift length (hours), and
- o the patrol interval (hours) set by agency policy.

The total number of deputies required for uncommitted patrol equals the sum of the number of deputies needed for each roadway type (Step 5.1.5). The derivation of the formula used in steps 5.1.2.6, 5.1.3.6, and 5.1.4.6 is presented in Section D.2 in Appendix D in the Guide.

The number of deputies required for rapid response is determined using either section 5.2 or 5.3. Section 5.2 determines the number of deputies that must be available during the hours of coverage to insure that at least one deputy will be available in the APA for immediate dispatch or action for a user-specified percentage of all accidents, CFS, and self-initiated activities. The number of required deputies is based on the number of deputies required for reactive activities, the immediate response percent set by the agency, the hours of patrol coverage per week, and the values determined for m_a and m_s in worksheets 2 and 4.

Two procedures are available for determining the number of deputies required for immediate availability. A simplified procedure based on Table 3-1 is presented in Section 5.2. If the simplifying assumptions used in Section 5.2 are not valid, a supplemental worksheet in Appendix A can be used. For either procedure, the final number of uncommitted patrol officers required is obtained from a table (either Table 3-1 for Section 5.2 or one of several tables in Appendix A) based on a queuing theory model that assumes that accidents, other CFS, and self-initiated

activities occur randomly and that service times are distributed exponentially. The derivations of the formulas and procedures used in Section 5.2 and in the Supplemental Worksheet are presented in Section D.3 in Appendix D in the Guide.

Section 5.3 determines the number of deputies that must be available in the APA to provide a specified average travel time. Steps (5.3.1) through (5.3.6) are used for patrol over a designated geographic area. A supplemental worksheet in Appendix B can be used when patrol is provided on a designated roadway segment (i.e., a line patrol). The value obtained from the supplemental worksheet is entered in Step (5.3.7) and the total number of deputies required to meet the travel time requirement is determined in Step (5.3.8).

The formula for the number of deputies required for area patrol (Step 5.3.6) is based on:

- shift length (hours),
- area (square miles) of the APA,
- patrol coverage per week (hours),
- average response speed (MPH), and
- average travel time specified by the agency.

The derivation of the formula for travel time for area patrol is presented in Section D.4 in Appendix D in the Guide.

The formula for the number of deputies required for line patrol (supplemental worksheet in Appendix B) is based on:

- shift length (hours),
- patrol coverage per week (hours),
- number of roadway miles,
- coverage per week (hours),
- average response speed (MPH), and
- average travel time specified by the agency.

The derivation of the formula for travel time for line patrol is presented in Section D.5 in Appendix D in the Guide.

Whether response time is based on area or line patrol or both, the average response speed that is used should be equal to or greater than the average patrol speed used in Section 5.1.

The average number of deputies per day for uncommitted patrol (N_p) is determined by calculating the number of deputies required for visibility (Step 5.1.5) and the number of deputies required for timely response (Step 5.4) and using the <u>larger</u> of the two values (Step 5.5).

Instructions for Individual Steps

5.1 Uncommitted Patrol Visibility

5.1.2.4 The average patrol speed (MPH) is defined as the average speed while on "uncommitted patrol" on category 1 roadways only. Uncommitted patrol is defined as the total shift time minus time spent on reactive (i.e., accidents and CFS), self-initiated, and administrative activities, and uncommitted time on non-category 1 roadways. Some agencies make a distinction between "moving" and "stationary" patrol. The PAM model does <u>not</u> make this distinction and the average patrol speed used in the PAM model should be based on <u>both</u> moving and stationary patrol time while on category 1 roadways. If the average patrol speed is known for moving patrol time only, it is possible to estimate the overall patrol speed with the formula given below.

Average Patrol Speed (MPH)	=	Average Patrol Speed (moving) (MPH)	x	Fraction of Time on Moving Patrol

As an example, if the average speed during moving patrol is estimated to be 40 MPH and moving patrol time represents approximately 50% of total uncommitted patrol time, then the average patrol speed that should be used in the PAM model is 20 MPH (i.e., 20 = 40 x .50). The fraction of time on moving patrol (a number between 0 and 1) is obtained by dividing the percent of time by 100. Notice that if all uncommitted patrol time is spent on moving patrol, the average speed patrol for the PAM model equals the average speed for moving patrol.

5.1.3.4 Average patrol speed on uncommitted time on category 2 roadways. See discussion above for Step 5.1.2.3.

5.1.4.4 Average patrol speed on uncommitted time on category 3 roadways. See discussion above for Step 5.1.2.3.

5.2 Uncommitted Patrol Availability - Immediate Response

Determination of the number of deputies needed for immediate response in Section 5.2 is based on three simplifying assumptions:

1. staffing is uniform over all shifts,
2. the values for $\mathbf{m_a}$ (Step 2.3) and $\mathbf{m_s}$ (Step 4.4) are approximately 15 and 9 minutes per hour per deputy respectively, and
3. the same user-specified immediate response performance objective is used for each shift.

If any of these assumptions is not valid, the user should use the supplemental worksheet in Appendix A to determine the number of deputies needed to satisfy the immediate response performance objective. As a rule of thumb, shift staffing can be considered uniform if the proportion of staff on each shift is within 10% of perfect uniform staffing for each shift. The table below indicates the range of staffing for operations with 2, 3, and 4 shifts.

Number of Shifts	------- Uniform Staffing -------- Percent of Staffing on Each Shift: Perfect	Range
2	50.0	45.0 - 55.0
3	33.3	30.0 - 36.7
4	25.0	22.5 - 27.5

5.2.6 Specify the percentage of calls for which at least one deputy will be available for immediate dispatch (P). Select a percentage value that corresponds to one of the columns in Table 3-1. The lowest value is 50% and the highest is 99%.

5.2.7 Determine the number of deputies needed with Table 3-1.

Using Table 3-1:

- Examine the left-hand column of the table and select the row that is closest to the average daily number of deputies per shift (Step 5.2.5) that are needed to handle the obligated time workload (N_r).

- Read across the row until the percentage at the top of the column equals or exceeds the agency performance objective percentage (Step 5.2.6).

- The table entry indicates the average number of deputies that are needed <u>on each shift</u> to meet the agency specified percentage. Enter the table value in (5.2.7).

5.3 Uncommitted Patrol Availability - Travel Time for Area Patrol and/or Line Patrol

This section is used to determine the average number of deputies required for uncommitted patrol within the APA during the hours of coverage to provide a user-specified <u>average</u> travel time response to CFS for area and/or line patrols. Steps 5.3.1 - 5.3.6 are used for area patrol. Step 5.3.7 is used to record the number of deputies required for line patrol obtained from the supplemental worksheet in Appendix B.

5.3.4 Average response speed (MPH) (D).

The average speed of a patrol unit while responding to a CFS. The average speed is usually lower than anticipated due to factors that may delay or impede a responding unit (e.g., heavy traffic, cornering, etc.)

5.3.5 Average travel time performance objective (minutes) (P).

The user-specificed average travel time performance objective for patrol unit response to accidents and other CFS within the APA. It is important to note that this procedure is based on the <u>average</u> travel time. The number of deputies determined in Step (5.3.6) will provide a level of availability that will produce travel times that collectively will equal the travel time objective value. For individual responses, however, some travel times will be lower than the objective value and some will be higher. The number of deputies obtained in Step (5.3.6) does <u>not</u> guarantee that the travel time to every incident will be less than the agency-specified objective value.

5.3.7 Number of deputies required for line patrol.

See discussion in Appendix B.

WORKSHEET 5: Proactive Time - Uncommitted Patrol

Objective: Determine the number of deputies required within the APA to provide an adequate level of visibility and availability.

Method: Based on: (1) the patrol interval, and (2) the probability of immediate response to accidents and other CFS or the average travel time to accidents and other CFS.

5.1 Uncommitted Patrol Visibility

5.1.1 Shift length (hours), use (1.2.1) . . . . . [ ] (5.1.1)

5.1.2 Number of deputies needed per day for uncommitted patrol on category 1 roadways in the APA

5.1.2.1 Category 1 roadway type, use (1.2.5.1) . . [ ] (5.1.2.1)

5.1.2.2 Miles of roadway, use (1.4.1) . . . . . [ ] (5.1.2.2)

5.1.2.3 Hours of coverage per week, use (1.2.5.2) . . . . [ ] (5.1.2.3)

5.1.2.4 Average patrol speed (MPH), use (1.2.5.3) . . . [ ] (5.1.2.4)

5.1.2.5 Performance objective patrol interval (hours), use (1.2.5.4) . . . . . .

(5.1.2.5)

5.1.2.6 Number of deputies required per day to meet the patrol interval performance objective for category 1 roadways in the APA, use the formula below . . .

(5.1.2.6)

$$\text{Number of Deputies (5.1.2.6)} = \frac{\text{Roadway Miles (5.1.2.2)} \times \text{Hours of Coverage Per Week (5.1.2.3)}}{7 \times \text{Average Patrol Speed (5.1.2.4)} \times \text{Shift Length (5.1.1)} \times \text{Perf. Obj. Patrol Interval (5.1.2.5)}}$$

5.1.3 Number of deputies needed per day for uncommitted patrol on category 2 roadways in the APA

5.1.3.1 Category 2 roadway type, use (1.2.6.1) . .

(5.1.3.1)

5.1.3.2 Miles of roadway, use (1.4.2) . . . . . .

(5.1.3.2)

5.1.3.3 Hours of coverage per week, use (1.2.6.2) . . . .

(5.1.3.3)

5.1.3.4 Average patrol speed (MPH), use (1.2.6.3) . . .

(5.1.3.4)

5.1.3.5 Performance objective patrol interval (hours), use (1.2.6.4) . . . . . .

(5.1.3.5)

5.1.3.6 Number of deputies required per day to meet the patrol interval performance objective for category 2 roadways in the APA, use the formula below . . .

(5.1.3.6)

$$\text{Number of Deputies (5.1.3.6)} = \frac{\text{Roadway Miles (5.1.3.2)} \times \text{Hours of Coverage Per Week (5.1.3.3)}}{7 \times \text{Average Patrol Speed (5.1.3.4)} \times \text{Shift Length (5.1.1)} \times \text{Perf. Obj. Patrol Interval (5.1.3.5)}}$$

5.1.4 Number of deputies needed per day for uncommitted patrol on category 3 roadways in the APA

5.1.4.1 Category 3 roadway type, use (1.2.7.1) . .

(5.1.4.1)

5.1.4.2 Miles of roadway, use (1.4.3) . . . . . .

(5.1.4.2)

5.1.4.3 Hours of coverage per week, use (1.2.7.2) . . . .

(5.1.4.3)

5.1.4.4 Average patrol speed (MPH), use (1.2.7.3) . . .

(5.1.4.4)

5.1.4.5 Performance objective patrol interval (hours), use (1.2.7.4) . . [ ] (5.1.4.5)

5.1.4.6 Number of deputies required per day to meet the patrol interval performance objective for category 3 roadways in the APA, within the APA, use use the formula below . . . [ ] (5.1.4.6)

$$\text{Number of Deputies (5.1.4.6)} = \frac{\text{Roadway Miles (5.1.4.2)} \times \text{Hours of Coverage Per Week (5.1.4.3)}}{7 \times \text{Average Patrol Speed (5.1.4.4)} \times \text{Shift Length (5.1.1)} \times \text{Perf. Obj. Patrol Interval (5.1.4.5)}}$$

5.1.5 Total number of deputies required per day to meet patrol interval performance objective within the APA, add: (5.1.2.6) + (5.1.3.6) + (5.1.4.6) . [ ] (5.1.5)

OPTION: Complete Section 5.2 <u>or</u> the Supplemental Worksheet in Appendix A <u>or</u> Section 5.3.

5.2 Uncommitted Patrol Availability - Immediate Response

5.2.1 Shift length (hours), use (1.2.1) . . . . . [ ] (5.2.1)

5.2.2 Coverage per week (hours), (maximum value = 168) . . . . . [ ] (5.2.2)

5.2.3 Calculate the effective number of shifts per day based on the formula below . . . . [ ] (5.2.3)

$$\text{Effective Number of Shifts Per Day (5.2.3)} = \frac{\text{Coverage Per Week (hours) (5.2.2)}}{7 \times \text{Shift Length (hours) (5.2.1)}}$$

5.2.4 Average daily number of on-duty deputies for reactive time, use (3.3.3) . . . . [ ] (N_r) (5.2.4)

5.2.5 Average daily number of on-duty deputies per shift (N_{rs}), divide: (5.2.4) ÷ (5.2.3) . . . . [ ] (N_{rs}) (5.2.5)

5.2.6 Performance objective, percentage of accidents, CFS, and self-initiated activities, immediate response (a number between 50 and 99) . . . . . [ ] (PIR%) (5.2.6)

5.2.7 Number of deputies required per shift, use (5.2.5), (5.2.6), and Table 3-1 . . . . . [ ] (5.2.7)

5.2.8 Total number of uncommitted patrol deputies required per day within the APA to provide immediate response to the performance objective percentage of accidents and CFS, either multiply: (5.2.3) x (5.2.7) or enter value from Step (A.7) . . . [ ] (5.2.8)

Table 3-1

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 0.25)

Number of Reactive Deputies (N_{rs}) (5.2.5)	----- Performance Objective Immediate Response Percentage (PIR%) (5.2.6) -----										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.3	0.4	0.6	0.8	0.9	1.1	1.4	2.0	2.4	2.7	3.3
.10	0.3	0.5	0.7	0.8	1.0	1.2	1.5	2.1	2.5	2.8	3.4
.15	0.3	0.5	0.8	0.9	1.1	1.3	1.6	2.2	2.6	2.9	3.5
.20	0.4	0.6	0.8	1.0	1.1	1.3	1.7	2.2	2.7	3.0	3.6
.25	0.4	0.6	0.9	1.0	1.2	1.4	1.7	2.3	2.8	3.1	3.7
.30	0.5	0.7	0.9	1.0	1.2	1.5	1.8	2.4	2.8	3.2	3.8
.40	0.5	0.7	1.0	1.1	1.3	1.6	1.9	2.5	3.0	3.4	4.0
.50	0.6	0.8	1.0	1.2	1.4	1.7	2.0	2.7	3.1	3.5	4.2
.60	0.6	0.8	1.1	1.3	1.5	1.7	2.1	2.8	3.3	3.6	4.3
.80	0.6	0.9	1.2	1.4	1.6	1.9	2.3	3.0	3.5	3.9	4.6
1.00	0.8	1.0	1.3	1.5	1.7	2.0	2.5	3.2	3.7	4.1	4.8
1.20	0.8	1.1	1.4	1.6	1.8	2.2	2.6	3.4	3.9	4.3	5.1
1.60	0.9	1.2	1.5	1.8	2.0	2.4	2.9	3.7	4.3	4.7	5.5
2.00	1.0	1.3	1.7	1.9	2.2	2.6	3.1	4.0	4.6	5.0	5.9
2.50	1.1	1.4	1.8	2.1	2.4	2.8	3.4	4.3	4.9	5.4	6.3
3.00	1.2	1.5	2.0	2.3	2.6	3.0	3.6	4.6	5.2	5.8	6.7
4.00	1.3	1.7	2.2	2.5	2.9	3.4	4.0	5.1	5.8	6.4	7.4
5.00	1.5	1.9	2.4	2.8	3.2	3.7	4.4	5.5	6.3	6.9	8.0

Continue with Section 5.4.

OR

5.3 Uncommitted Patrol Availability - Travel Time for Area Patrol (Steps 5.3.1 - 5.3.6) and/or Line Patrol (Step 5.3.7)

5.3.1 Shift length (hours), use (1.2.1) . . . . . [ ] (5.3.1)

5.3.2 Coverage per week (hours) (maximum value = 168) . . . . . [ ] (5.3.2)

5.3.3 Area (square miles) of the APA . . . . . [ ] (5.3.3)

5.3.4 Average response speed (MPH) (equal to or greater than average patrol speed) . . . . . [ ] (5.3.4)

5.3.5 Average travel time performance objective (minutes) . . . . . [ ] (5.3.5)

5.3.6 Number of deputies required within the APA to meet the average travel time performance objective for area patrol

5.3.6.1 Calculate **K** based on formula below . . . . . [ ] (5.3.6.1) **(K)**

$$K = \frac{40}{\text{Speed (MPH) (5.3.4)} \times \text{Time (min) (5.3.5)}}$$

5.3.6.2 Calculate **K** x **K**, multiply: (5.3.6.1) x (5.3.6.1) . . . [ ] (**K²**)

(5.3.6.2)

5.3.6.3 Number of deputies required for area patrol, use the formula below . . . [ ]

(5.3.6.3)

$$\text{No. of On-Duty Deputies, Area Patrol (5.3.6.3)} = \frac{K^2 \text{ (5.3.6.2)} \times \text{Area (5.3.3)} \times \text{Coverage Per Week (Hours) (5.3.2)}}{7 \times \text{Shift Length (hours) (5.3.1)}}$$

5.3.7 Number of deputies required within the APA for line patrol, enter zero or the value from Step (B.6) . . . . . [ ]

(5.3.7)

5.3.8 Total number of deputies required within the APA for area and line patrol, add: (5.3.6.3) + (5.3.7) . . . . . [ ]

(5.3.8)

5.4 Uncommitted Patrol Availability

Total deputies required within the APA, select either (5.2.8) <u>or</u> (5.3.8) . . . . . [ ]

(5.4)

5.5 Total Number of Deputies Required for Uncommitted Patrol

Average number of deputies (N_p) required per day for uncommitted patrol within the APA, select the <u>larger</u> of (5.1.5) and (5.4) . . . . . .

(5.5) (N_p)

Instructions for Worksheet 6: Average Daily Number of On-Duty Deputies

Worksheet 6 uses information from worksheets 2, 3, 4, and 5 to determine the average number of on-duty deputies that are needed per day within the APA. The formula for the average number of on-duty deputies (Step 6.1.5) is based on:

- the average number of on-duty deputies needed for reactive activities (N_r),
- the average number of on-duty deputies needed for uncommitted patrol (N_p),
- the average number of minutes per hour per deputy spent on administrative activities (m_a), and
- the average number of minutes per hour per deputy spent on self-initiated activities (m_s).

The derivation of the formula for Step (6.1.5) is presented in Section D.6 in Appendix D in the Guide.

Sections 6.2 and 6.3 are used to add deputies to account for the use of two-deputy patrol units and the presence of minimum staffing requirements set by the agency. The derivation of the formula for adjusting the number of on-duty deputies for two-deputy units is presented in Section D.7 in Appendix D in the Guide.

Instructions for Individual Steps

6.1 Number of On-Duty Deputies per Day - All One-Deputy Patrols (C)

With the completion of Step 6.1.5, it is possible to determine how much time each deputy, on the average, will spend on each of the four work categories: reactive, self-initiated, uncommitted patrol, and administrative. The four times are given by:

Administrative Time (min/hr) = m_a (Step 2.3),

Self-Initiated Time (min/hr) = m_s (Step 4.4),

$$\text{Reactive Activities Time } (m_r) \text{ (min/hr)} = \frac{N_r\ (3.3.3) \times 60}{N_o\ (6.1.5)}, \text{ and}$$

$$\text{Uncommitted Patrol Time (min/hr)} = 60 - m_a - m_s - m_r .$$

The four times will sum to 60 minutes. The time (in hours) spent on each activity for an entire shift can be determined by dividing each time by 60 and multiplying by the shift length (in hours).

6.2 Adjustment for Two-Deputy Patrol Units (P).

6.2.1 The percentage of time that patrol units are staffed with two deputies. A value of 0 indicates that no patrol units within the APA are staffed with two deputies while a value of 100 indicates that every patrol unit has two deputies.

6.2.3 The adjustment factor is a number between 1 and 2 that is derived from the percentage entered for (6.2.1). The factor indicates the average number of deputies per unit. A value of 1 indicates an average of one deputy per unit (i.e., no two-deputy units are used). A value of 2 indicates that every unit has two deputies.

6.3 Minimum Staffing Level

The minimum number of on-duty deputies that must be available each day in the APA as determined by agency policy.

WORKSHEET 6: Average Daily Number of On-Duty Deputies

Objective: Determine the average total number of deputies required per day within the APA.

Method: Combine the total number of deputies required for reactive (N_r) and patrol activities (N_p) with the per deputy time requirements for self-initiated (m_s) and administrative (m_a) activities. Adjust the required number of deputies based on the percentage of two-deputy patrols and, if applicable, minimum daily staffing levels.

6.1 Number of On-Duty Deputies per Day - All One-Deputy Patrols

6.1.1 Administrative time - minutes per hour per deputy, use (2.3) . . . . . [ ] (m_a) (6.1.1)

6.1.2 Average number of deputies required per day to meet reactive time workload, use (3.3.3) . . . . . [ ] (N_r) (6.1.2)

6.1.3 Self-initiated time - minutes per hour per deputy, use (4.4) . . . . . [ ] (m_s) (6.1.3)

6.1.4 Average number of deputies required per day to meet patrol time requirements, use (5.5) . . . [ ] (N_p) (6.1.4)

6.1.5 Average total number of on-duty deputies required per day for all patrol activities within the APA, one deputy per unit, use the formula below . . . . . [ ] (6.1.5)

$$\text{Average Total Number of On-Duty Deputies Per Day (6.1.5)} = \frac{N_r\ (6.1.2) + N_p\ (6.1.4)}{1 - \dfrac{m_a\ (6.1.1)}{60} - \dfrac{m_s\ (6.1.3)}{60}}$$

6.2 Adjustment for Two-Deputy Patrols

<u>NOTE</u>: If two-deputy patrols are not used, enter (6.1.5) into (6.2.4) and continue with Section 6.3.

6.2.1 Percentage of time patrol units within the APA are staffed with two deputies . . . . [ ] (6.2.1)

6.2.2 Fraction of time patrol units within the APA are staffed with two deputies, divide: (6.2.1) ÷ 100 . . . . . [ ] (6.2.2)

6.2.3 Adjustment factor: average number of deputies per unit, add: 1 + (6.2.2) . . . . . [ ] (6.2.3)

6.2.4 Average total number of on-duty deputies required per day for all patrol activities, multiply: (6.1.5) x (6.2.3) . . . . . [ ] (6.2.4)

6.3 Adjustment for Minimum Staffing Levels

Note: If minimum staffing levels are not used, enter (6.2.4) into (6.3.2) and continue with Worksheet 7.

6.3.1 Average minimum number of on-duty deputies required per day for all patrol activities, based on agency policy . . . . . [ ] (N_{min})

(6.3.1)

6.3.2 Average daily number of on-duty deputies required for all patrol activities (N_o), select the larger of (6.2.4) and (6.3.1) . . [ ] (N_o)

(6.3.2)

Instructions for Worksheet 7: Special Assignments and Field Supervision

Worksheet 7 is used to determine the impact of special assignment units (e.g., inspections, K9, accident investigation, etc.) on total patrol staffing and the number of field supervisors required in the APA.

The impact of special assignment personnel is based on the number of on-duty deputies required for each type of specialized unit (specified by the agency) and the percentage of patrol work, if any, performed by the specialists. The procedure assumes that the number of deputies on special assignments is permanent (i.e., that they will continue on the assignment for an indefinite period of time). Additional staffing for non-permanent or temporary assignments such as traffic and crowd control at special events (e.g., a county fair) is considered in the derivation of the shift relief factor in Worksheet 8.

The number of field supervisors is based on the span of supervision (i.e., the average number of deputies that report to each field supervisor) set by agency policy and the amount of patrol work done by each field supervisor.

The derivations of the formulas used for steps 7.1.6, 7.2.1.6, 7.2.2.6, 7.2.3.6, 7.2.4, and 7.3.1 are presented in Section D.8 of Appendix D in the Guide.

Instructions for Individual Steps

Since field supervisors, and deputies assigned to special assignments, may spend part of their time performing patrol activities, the addition of field supervisors and special assignment personnel to the patrol force may reduce the number of full-time (i.e., non-supervisory and non-special assignment) deputies that are needed. The number of on-duty deputies determined in sections 7.1 and 7.2 consists of an adjusted number of full-time deputies and the number of deputies used for special assignments.

7.1 Number of full-time, on-duty deputies required per day, adjusted for field supervisors (P,D,C)

The adjusted number of full-time, on-duty deputies (N_{ao}) is based on the number of deputies (N_o) derived in Step 6.3.2, the average number of deputies supervised by each field supervisor (Step 7.1.1), and the percentage of on-duty time field supervisors spend on patrol activities (i.e., time spent on reactive, self-initiated, uncommitted patrol, and

non-supervisory administrative work) (Step 7.1.2). If field supervisors spend no time on patrol activities, then the adjusted number of full-time, on-duty deputies required is unchanged (i.e., $N_{ao} = N_o$).

7.2 Number of on-duty deputies required per day, adjusted for special assignment personnel (D,C)

If special assignment personnel are used, Section 7.2 can be used for up to three types of special assignments, and can be easily modified by the user if more than three are needed. The adjustment is based on the adjusted number of full-time, on-duty deputies ($\mathbf{N_{ao}}$) derived in Step 7.1.6; the number of on-duty deputies required for special assignments (i.e., $\mathbf{N_{s1}}$, $\mathbf{N_{s2}}$, and $\mathbf{N_{s3}}$ in steps 7.2.1.1, 7.2.2.1, and 7.2.3.1); and the percentage of time special assignment personnel spent on patrol activities (i.e., time spent on reactive, self-initiated, uncommitted patrol, and patrol-related administrative work) (steps 7.2.1.2, 7.2.2.2, and 7.2.3.2). The final adjusted value for the number of on-duty deputies required per day ($\mathbf{N_{ot}}$) is determined in Step 7.2.4 and includes both full-time patrol deputies and deputies who spend all or part of their time on special assignments.

Note that the number of full-time, on-duty deputies per day ($\mathbf{N_{ft}}$) is given by:

$$N_{ft} = \underset{(7.2.4)}{N_{ot}} - \underset{(7.2.1.1)}{N_{s1}} - \underset{(7.2.2.1)}{N_{s2}} - \underset{(7.2.3.1)}{N_{s3}}$$

7.3 Total number of on-duty field supervisors ($\mathbf{N_{os}}$) required per day for the adjusted number of on-duty deputies ($\mathbf{N_{ot}}$) (C)

The number of on-duty field supervisors ($\mathbf{N_{os}}$) is based on the adjusted number of on-duty deputies ($\mathbf{N_{ot}}$) from Step 7.2.4 and the number of deputies assigned to each field supervisor (Step 7.1.1). The value determined for $\mathbf{N_{os}}$ in Step 7.3.1 includes supervisors for both full-time patrol deputies and deputies assigned to special units.

WORKSHEET 7: Special Assignments and Field Supervision

Objective: Determine (1) the revised number of on-duty deputies required per day because of deputies on special assignments and (2) the number of field supervisors required.

Method: The number of deputies for special assignments is based on the number of specialists assigned by the agency and the percentage of time each spends on field patrol activities. The number of field supervisors is based on the span of supervision (set by agency policy) and the percentage of field supervisor on-duty time spent on patrol activities.

7.1 Number of Full-Time, On-Duty Deputies Required per Day, Adjusted for Field Supervisors

7.1.1 Average number of deputies to be supervised by each field supervisor, use (1.2.3) . . . . . [ ] (7.1.1)

7.1.2 Percentage of field supervisor on-duty time spent on patrol activities (a number between 0 and 100), use (1.2.4) . . . . . [ ] (7.1.2)

7.1.3 Fraction of field supervisor on-duty time spent on patrol activities, divide: (7.1.2) ÷ 100 . . . . . [ ] (7.1.3)

7.1.4 Total number of on-duty deputies required per day within the APA (N_o) for all patrol activities, use (6.3.2) . . . . . [ ] (N_o) (7.1.4)

7.1.5 Adjustment factor (K_f), use formula below . . . . . [ ] (K_f)
(7.1.5)

$$\text{Adjustment Factor } (K_f) \text{ (7.1.5)} = \frac{\text{Deputies Per Field Sup. (7.1.1)}}{\text{Deputies Per Field Sup. (7.1.1)} + \text{Fraction of Field Sup. Time on Patrol (7.1.3)}}$$

7.1.6 Adjusted daily number of full-time, on-duty deputies (N_{ao}) required per day, use formula below . . . . . [ ] (N_{ao})
(7.1.6)

$$\text{Adjusted Number of Full-Time, On-Duty Deputies Per Day } (N_{ao}) \text{ (7.1.6)} = K_f \times \text{No. of On-Duty Deputies Per Day } (N_o) \text{ (7.1.4)}$$

NOTE: If no special assignment personnel are to be included, enter (7.1.6) into (7.2.4) and continue with Section 7.3. If special assignment personnel are to be included, continue with Section 7.2.

7.2 Number of On-Duty Deputies Required Per Day, Adjusted for Special Assignment Personnel

7.2.1 Special Assignment 1

7.2.1.1 Assign. 1 name . [ ]
(7.2.1.1)

7.2.1.2 Average number of <u>on-duty</u> deputies per day on specialized assignment 1 . . . . . [ ] (N_{s1})
(7.2.1.2)

7.2.1.3 Percentage of on-duty time spent on patrol activities by deputies assigned to special assignment 1 (a number between 0 and 100) . . . . [ ]
(7.2.1.3)

7.2.1.4 Percentage of on-duty time spent on non-patrol activities by deputies assigned to special assignment 1, subtract: 100 - (7.2.1.3) . . . . . [ ]
(7.2.1.4)

7.2.1.5 Fraction of on-duty time spent on non-patrol activities by deputies assigned to special assignment 1, divide: (7.2.1.4) ÷ 100 . . . . . [ ] (f_{s1})
(7.2.1.5)

7.2.1.6 Adjusted daily number of on-duty deputies assigned to special assignment 1, use formula below . . . . . [ ] (N_{as1})
(7.2.1.6)

Adjusted Number On-Duty Deputies, Special Assignment 1 (N_{as1}) (7.2.1.6)	=	Number On-Duty Deputies S.A. 1 (N_{s1}) (7.2.1.2)	x	Fraction Time On Non-Patrol Activities (f_{s1}) (7.2.1.5)	x	Adjustment Factor (K_f) (7.1.5)

NOTE: If personnel for a second special assignment are to be included, complete steps (7.2.2.1) through (7.2.2.6). If not, enter zeros for steps (7.2.2.6) and (7.2.3.6) and continue with Step 7.2.4.

7.2.2 Special Assignment 2

7.2.2.1 Assign. 2 name . [ ] (7.2.1.1)

7.2.2.2 Average number of <u>on-duty</u> deputies per day on specialized assignment 2 . . . . . [ ] (N_{s2}) (7.2.2.2)

7.2.2.3 Percentage of on-duty time spent on patrol activities by deputies assigned to special assignment 2 (a number between 0 and 100) . . . . [ ] (7.2.2.3)

7.2.2.4 Percentage of on-duty time spent on non-patrol activities by deputies assigned to special assignment 2, subtract: 100 - (7.2.2.3) . . . . . [ ] (7.2.2.4)

7.2.2.5 Fraction of on-duty time spent on non-patrol activities by deputies assigned to special assignment 2, divide: (7.2.2.4) ÷ 100 . . . . . [ ] (f_{s2}) (7.2.2.5)

7.2.2.6 Adjusted daily number of on-duty deputies assigned to special assignment 2, use formula below . . . . . [ ] (N_{as2}) (7.2.2.6)

Adjusted Number On-Duty Deputies, Special Assignment 2 (N_{as2}) (7.2.2.6)	=	Number On-Duty Deputies S.A. 2 (N_{s2}) (7.2.2.2)	x	Fraction Time On Non-Patrol Activities (f_{s2}) (7.2.2.5)	x	Adjustment Factor (K_f) (7.1.5)

NOTE: If personnel for a third special assignment are to be included, complete steps (7.2.3.1) through (7.2.3.6). If not, enter zero for step (7.2.3.6) and continue with Step 7.2.4.

7.2.3 Special Assignment 3

7.2.3.1 Assign. 3 name . [ ] (7.2.3.1)

7.2.3.2 Average number of <u>on-duty</u> deputies per day on specialized assignment 3 . . . . . [ ] (N_{s3}) (7.2.3.2)

7.2.3.3 Percentage of on-duty time spent on patrol activities by deputies assigned to special assignment 3 (a number between 0 and 100) . . . . [ ] (7.2.3.3)

7.2.3.4 Percentage of on-duty time spent on non-patrol activities by deputies assigned to special assignment 3, subtract: 100 - (7.2.3.3) . . . . . [ ] (7.2.3.4)

7.2.3.5 Fraction of on-duty time spent on non-patrol activities by deputies assigned to special assignment 3, divide: (7.2.3.4) ÷ 100 . . . . . [ ] (f_{s3})

(7.2.3.5)

7.2.3.6 Adjusted daily number of on-duty deputies assigned to special assignment 3, use formula below . . . . . [ ] (N_{as3})

(7.2.3.6)

Adjusted Number On-Duty Deputies, Special Assignment 3 (N_{as3}) (7.2.3.6)	=	Number On-Duty Deputies S.A. 3 (N_{s3}) (7.2.3.2)	x	Fraction Time On Non-Patrol Activities (f_{s3}) (7.2.3.5)	x	Adjustment Factor (K_f) (7.1.5)

7.2.4 Adjusted total daily number of on-duty deputies required per day, use formula below . . . . . [ ] (N_{ot})

(7.2.4)

Adjusted Total Number of On-Duty Deputies Per Day (N_{ot}) (7.2.4)	=	N_{ao} (7.1.6)	+	N_{as1} (7.2.1.6)	+	N_{as2} (7.2.2.6)	+	N_{as3} (7.2.3.6)

7.3 Total Number of On-Duty Field Supervisors Required Per Day for the Adjusted Number of On-Duty Deputies

7.3.1 Total number of on-duty field supervisors (N_{os}) required per day, day, divide: (7.2.4) ÷ (7.1.1) . . [ ] (N_{os})

(7.3.1)

Instructions for Worksheet 8: Total Staff Requirements

Worksheet 8 is used to determine the total staff needed to support the on-duty deputy and field supervisor requirements determined in worksheets 6 and 7. The total staff requirements for the APA are derived using the following procedure:

- Sections 8.1, 8.2, and 8.3 are used to determine the total number of deputies and field supervisors, both on and off-duty, that are needed.
- Section 8.4 is used to indicate the total number of staff and command personnel that are required.
- Section 8.5 is used to collect the results into a final tabulation of the total staff requirements for the APA.

The total number of deputies and field supervisors required is determined based on the shift relief factor for the APA. The shift relief factor is defined as the average number of persons required to staff one shift position per day, 365 days a year. The shift relief factor for an APA is calculated with the following formula:

$$\text{Shift Relief Factor} = \frac{\text{Total Number of Hours To Cover One Shift Position Per Day, 365 Days Per Year}}{\text{Average Number of Actual On-Duty Hours On Patrol Per Person Per Year}}$$

The average number of actual on-duty hours on patrol per person per year is determined by the average work week, the shift length, the benefit time policies (i.e., vacation time, holiday leave, sick leave, etc.) of the agency, and the extent to which deputies are used for non-patrol activities. For agencies with eight-hour shifts, shift relief factors usually fall between 1.60 and 1.90. Derivation of the shift relief factor formula is presented in Section D.9 in Appendix D in the Guide.

To indicate the number of staff and command personnel, the user must specify the number directly in Section 8.4.

Instructions for Individual Steps

8.2 Shift Relief Factor

8.2.7 Average number of on-duty hours on patrol per officer per year

This value is obtained by taking the total hours that an officer is paid per year (Step 8.2.4) and subtracting the total hours for benefit time (Step 8.2.5) and temporary assignments (Step 8.2.6).

8.4 The Number of Staff and Command Personnel - Agency Policy (P).

This category should include all command personnel (e.g., lieutenants, captains, majors, etc.) and other staff personnel (i.e., administrative, technical, etc.) that are needed for the supervision and support of the patrol force within the APA. The specific kinds of personnel included in this category will vary from agency to agency.

WORKSHEET 8: Total Staff Requirements

Objective: Determine total staff needed to support the required daily on-duty field personnel.

Method: Use the shift relief factor, daily on-duty staff requirements, and the number of staff and command positions based on agency policy.

8.1 On-Duty Deputies and Field Supervisors Required per Day

8.1.1 Total number of on-duty deputies per day within the APA, use (7.2.4) . . . . . [ ] (8.1.1) (N_{ot})

8.1.2 Total number of on-duty field supervisors per day within the APA, use (7.3.1) . . . . . [ ] (8.1.2) (N_{os})

8.2 Shift Relief Factor

8.2.1 Shift length (hours), use (1.2.1) . . . . . [ ] (8.2.1)

8.2.2 Total hours on one shift during one year, multiply: 365 x (8.2.1) . . . . . [ ] (8.2.2) (H_t)

8.2.3 Average work week (average number of paid hours per week per officer), use (1.2.2.1) . . . [ ] (8.2.3) (AWW)

8.2.4 Average number of paid hours of work per year per officer, use formula below . . . . . [ ] (H_y)
(8.2.4)

$$\text{Average Number of Paid Hours of Work per Year per Officer } (H_y) = \frac{365 \times \text{AWW } (8.2.3)}{7}$$

8.2.5 Average number of benefit (paid) hours off per year per officer, use (1.2.2.2) . . . . [ ] (H_b)
(8.2.5)

8.2.6 Average number of on-duty hours on temporary assignments (non-patrol) per officer per year, use (1.2.2.3) . . . . . [ ] (H_{ta})
(8.2.6)

8.2.7 Average number of on-duty, hours on patrol per year per officer, use formula below . . . . [ ] (H_{np})
(8.2.7)

$$\text{Average Number of On-Duty Hours On Patrol per Year per Officer } (H_{np}) = \underset{(8.2.4)}{H_y} - \underset{(8.2.5)}{H_b} - \underset{(8.2.6)}{H_{ta}}$$

8.2.8 Shift relief factor divide: (8.2.2) ÷ (8.2.7) . . . . [ ] (SRF)
(8.2.8)

8.3 Total Number of Required Deputies and Field Supervisors Within the APA

8.3.1 Total number of deputies, multiply: (8.1.1) x (8.2.8) . . . [ ] (N_t)
(8.3.1)

8.3.2 Total number of field supervisors, multiply: (8.1.2) x (8.2.8) . . . . . [ ] (N_s)
(8.3.2)

8.3.3 Total number of deputies and field supervisors, add: (8.3.1) + (8.3.2) . . . . . [ ]
(8.3.3)

8.4 Number of Staff and Command Personnel - Agency Policy

Select number of staff and command personnel required for the number of deputies and field supervisors given in (8.3.3) . . . . . [ ]
(8.4)

8.5 Total Staff Requirements for the APA

8.5.1 Number of deputies within the APA, use (8.3.1) . . . . . [ ] (N_t)
(8.5.1)

8.5.2 Number of field supervisors within the APA, use (8.3.2) . . . [ ] (N_s)
(8.5.2)

8.5.3 Number of staff and command personnel within the APA, use (8.4) . . . . . [ ] (N_h)
(8.5.3)

8.5.4 Total required staff for the APA, add: (8.5.1) + (8.5.2) + (8.5.3) . . . . [ ] (N_{tot})
(8.5.4)

Chapter 4: PAM Instructions and Worksheet for Allocating Personnel Among Several APAs

Introduction

This chapter describes a systematic procedure for allocating personnel for police traffic services over several APAs based on staffing estimates obtained from the procedures described in the eight worksheets in Chapter 3. The allocation procedure is presented in Worksheet 9 which uses the same data entry format as the worksheets in Chapter 3.

Throughout this chapter, the terms "personnel" and "staff" are used generically to refer to deputies, field supervisors, and support and command staff who are to be added or subtracted from current staffing levels or be reallocated among several APAs.

To facilitate the allocation procedure, the data items and calculations for each step in Worksheet 9 can be recorded in the Table 4-1 at the end of this chapter. The table provides for up to six APAs, but the format can be easily modified to accommodate any number of patrol areas. Each step in Worksheet 9 indicates where the entry should be placed in Table 4-1.

To use Worksheet 9 and Table 4-1, the user must provide the following information:

- the total number of personnel that will be added to or subtracted from the current staff assigned to the APAs (Step 9.1.1),
- the number of personnel currently assigned to each APA (Step 9.1.3), and
- the number of personnel estimated by the PAM model for each APA (Step 9.1.5).

The total number of personnel included in the reallocation consists of the number of current staff (**TC**) plus the number to added or subtracted (**TA**). If personnel are to be subtracted (noted in Worksheet 9 as **-TA**), then the total number to be allocated will be equal to **TC** minus **TA**. Worksheet 9 and Table 4-1 are used to derive two allocations for the total personnel:

- Unconstrained (Section 9.1) - The values recorded in Column 3 of Table 4-1 indicate the reallocation of all personnel based on the PAM estimates. This allocation is "unconstrained" because:

  - there are no limitations on the final number of personnel that can be assigned to each APA (i.e., each APA may gain or lose personnel), and

  - all personnel, both current and new, are eligible for reassignment.

- Constrained (Section 9.2) - The values recorded in Column 8 of Table 4-1 indicate a reallocation of personnel by APA based on the limitation that none of the personnel currently assigned to an APA can be reassigned. Application of this limitation produces the following effects:

  - Only personnel being added to the current staff are considered for allocation. As a result, no APA will lose personnel because of the reallocation. (New personnel are only added to APAs that are understaffed and no personnel are added to APAs that are overstaffed.) Under this limitation, however, it is possible that some APAs that were understaffed before the reallocation will continue be understaffed even after the staff additions.

  - If a reduction in the total number of current personnel is considered, no reassignment of the remaining personnel is permitted. As a result, no APA will gain personnel because of the reallocation. (Personnel are only taken from APAs that are overstaffed and no personnel are taken from APAs that are understaffed.) It is possible, however, that some APAs that were overstaffed before the personnel reductions will continue to be overstaffed even after the reallocation.

The derivations of the formulas for both unconstrained and constrained allocations are presented in Section D.10 in Appendix D in the Guide.

Although Worksheet 9 and Table 4-1 are designed for the allocation of staff over geographic areas (i.e., over several APAs), the procedure described in Worksheet 9 can also be used to allocate staff over several time periods (e.g., shifts or days of the week). Such allocations, however, require that PAM staffing estimates be determined for each time period (e.g., for each of

three shifts) for each APA.

Instructions for Individual Steps

9.1 Unconstrained Allocation

9.1.1 Indicate either the total number of personnel that is to be added to the APAs or the total number of personnel to be subtracted. Typically, the number of new personnel is determined by the number of graduates from the training academy. The number of personnel to be added is entered as a positive number in 9.1.1. If personnel reductions are planned, the total size of the staff reduction is entered as a negative number in 9.1.1.

The value entered in 9.1.1 (TA) should also be entered in Table 4-1 in following locations: at the top of the page in the box labeled (TA), in the Sum Check row for columns 6 and 7, and, after being multiplied by minus one, in the Sum Check row for Column 4.

9.1.2 Determine the total number of current personnel in the APAs. The value is entered in 9.1.2 and in the Sum Check row for column 1 in Table 4-1.

The sum of (9.1.1) and (9.1.2) is entered in the Sum Check row for columns 3 and 8.

9.1.3 Determine the current number of personnel in each APA and enter the values in column 1 in Table 4-1.

9.1.4 The sum of column 1 should equal the Sum Check amount (9.1.2).

9.1.5 Determine the number of personnel estimated by the PAM model for each APA and enter the values in column 2 in Table 4-1.

9.1.7 The unconstrained allocation results for each APA are recorded in column 3 in Table 4-1.

Note: If a value of zero is entered for (9.1.1) (i.e., TA = 0), then the results in column 3 will indicate the unconstrained allocation of the current number of personnel assigned to the APAs.

9.1.8 The sum of column 3 must equal the Sum Check amount given by (9.1.1) + (9.1.2).

9.2 Constrained Allocation

9.2.1 The values in column 4 are computed by taking the difference between the current number of personnel (column 1) and the unconstrained allocation of personnel (column 3) for each APA. A positive value indicates that the APA is overstaffed when compared to the reallocation based on the adjusted number of personnel (TC + TA). A negative value indicates that the APA is understaffed.

9.2.2 The sum of the values in column 4 must equal the number of personnel, multiplied by minus one (-1), to be added or reduced (i.e., -1 x (9.1.1)). As an example, if the number of personnel to be added is 10, then the sum of column 4 must equal -10.

9.2.3 Additional Personnel (TA(9.1.1) ≥ 0)

9.2.3.1 Based on the values in column 4, identify which APAs are overstaffed (indicated by a positive value in column 4) and which APAs are understaffed (indicated by a negative value in column 4). If an APA is overstaffed, a zero is entered in column 5. If an APA is understaffed, the negative value in column 4 is entered in column 5. When completed, every entry in column 5 should either be zero or a negative number.

9.2.3.3 Based on the formula given in Step 9.2.3.3, determine the number of personnel to be added to each APA and enter the values in column 6.

9.2.4 Personnel Reduction (TA(9.1.1) < 0)

9.2.4.1 Based on the values in column 4, identify which APAs are overstaffed (a positive value in column 4) and which APAs are understaffed (a negative value in column 4). If an APA is overstaffed, the positive value in column 4 is entered in column 5. If an APA is understaffed, a zero is entered in column 5. When completed, every entry in column 5 should either be zero or a positive number.

9.2.4.3 Based on the formula given in Step 9.2.4.3, determine the number of personnel to be subtracted from each APA and enter the values in column 6.

9.2.5 The sum of column 6 must equal the Sum Check amount (9.1.1) (**TA**).

9.2.6 Determine the number of personnel to be added or subtracted from each APA by rounding each value in column 6 to a whole number and entering the result in column 7.

9.2.7 The sum of the values in column 7 must equal the Sum Check amount (9.1.1) (**TA**). If the sum does not equal (9.1.1), then one or more the rounded values must be changed.

9.2.8 Determine the number of personnel in each APA for the constrained allocation by adding the values in columns 1 and 7 and entering the result in column 8.

9.2.9 The sum of the values in column 8 must equal the number of current personnel plus the number of persons to be added or subtracted.

WORKSHEET 9: Allocation of Patrol Personnel Among Several APAs

Objective: Determine the appropriate number of personnel to be assigned to each APA based on the estimated PAM staffing levels for each APA.

Method: Based on the number of personnel estimated for each APA, two reallocations of current and new personnel are determined. The unconstrained allocation redistributes all personnel, both current and new, among the APAs in the same proportion as the PAM estimates. The constrained allocation restricts the allocation to only new (or reduced) personnel insuring that no APA loses staffing when new personnel are added (or that no APA gains staffing when personnel reductions are applied).

9.1 Unconstrained Allocation

9.1.1 Total number of new personnel for all APAs, (enter zero if none or a negative value for personnel reductions) . . . . . Table 4-1 (9.1.1) **(TA)**

Enter (9.1.1) in Table 4-1 at four locations: in the box labeled **(TA)**, in the Sum Check row for columns 6 and 7, and multiplied by -1 in the Sum Check row for column 5.

9.1.2 Total number of current personnel for all APAs . . . . . Column 1 (9.1.2) **(TC)**

Enter (9.1.2) in the Sum Check row for column 1 in Table 4-1.

9.1.3 Number of current personnel for each APA, enter in column 1 in Table 4-1 . . . . . .

Column 1

(9.1.3)

9.1.4 Sum the values in column 1 and enter in the Col. Sum row . . . .

Column 1

(9.1.4)

Compare (9.1.4) with the Sum Check value (9.1.2) in column 1. If values agree, continue with Step 9.1.5.

9.1.5 Number of personnel estimated by PAM for each APA, enter in column 2 in Table 4-1 . . . .

Column 2

(9.1.5)

9.1.6 Sum the values in column 2 and enter in the Col. Sum row . . . .

Column 2 **(TE)**

(9.1.6)

9.1.7 The unconstrained reallocation for each APA, use the formula below and enter in column 3 in Table 4-1 . . . . . .

Column 3

(9.1.7)

$$\text{Column 3 Entry (9.1.7)} = \frac{\underset{(9.1.1)}{TA} + \underset{(9.1.2)}{TC}}{\underset{(9.1.6)}{TE}} \times \text{PAM APA Est. Column 2 (9.1.5)}$$

9.1.8 Sum the values in column 3 and enter in the Col. Sum row . . . .

Column 3

(9.1.8)

Compare (9.1.8) with the Sum Check value in column 3 (equal to the sum (9.1.1) + (9.1.2)). If the values agree, continue with Section 9.2.

9.2 Constrained Allocation

9.2.1 Difference in personnel between the current staffing and the unconstrained allocation for each APA, subtract:
Col. 1. (9.1.3) - Col. 3. (9.1.5) and enter in column 4 . . . . . .

Column 4
(9.2.1)

9.2.2 Sum the values in column 4 and enter in the Col. Sum row . . . .

Column 4
(9.2.2)

Compare (9.2.2) with the Sum Check value in column 4 (equal to -1 x (9.1.1)). If the values agree, continue with Step 9.2.3 <u>or</u> Step 9.2.4.

NOTE: Complete Section 9.2.3 <u>or</u> Section 9.2.4. If TA (9.1.1) is greater than or equal to zero, continue with Step 9.2.3. If TA (9.1.1) is less than zero, continue with Step 9.2.4.

9.2.3 Additional Personnel (TA(9.1.1) ≥ 0)

9.2.3.1 Understaffing indicator for each APA, use rules below and enter in column 5 . . . . . .

Column 5
(9.2.3.1)

If column 4 entry is:

- greater than or equal to zero, enter 0 in column 5.
- less than zero, enter column 4 value in column 5.

9.2.3.2 Sum the values in column 5 and enter in the Col. Sum row . . . . . Column 5 (9.2.3.2) **(TN)**

9.2.3.3 Number of personnel to be added to each APA, use the formula below and enter in column 6 . . Column 6 (9.2.3.3)

$$\text{Column 6 Entry (9.2.3.3)} = \frac{\text{TA (9.1.1)} \times \text{Column 5 (9.2.3.1)}}{\text{TN (9.2.3.2)}}$$

Continue with Step 9.2.5.

OR

9.2.4 Personnel Reduction (TA(9.1.1) < 0)

9.2.4.1 Overstaffing indicator for each APA, use rules below and enter in column 5 . . . . . Column 5 (9.2.4.1)

If column 4 entry is:

- greater than zero, enter column 4 value in column 5.
- less than or equal to zero, enter 0 in column 5.

9.2.4.2 Sum the values in column 5 and enter in the Col. Sum row . . . . . Column 5 (9.2.4.2) **(TN)**

9.2.4.3 Number of personnel to be added to each APA, use the formula below and enter in column 6 . .

Column 6

(9.2.4.3)

$$\text{Column 6 Entry (9.2.4.3)} = \frac{\text{TA (9.1.1)} \times \text{Column 5 (9.2.4.1)}}{\text{TN (9.2.4.2)}}$$

9.2.5 Sum the values in column 6 and enter in the Col. Sum row . . . .

Column 6

(9.2.5)

Compare (9.2.5) with the Sum Check value in column 6 (equal to (9.1.1)). If the values agree, continue with Step 9.2.6.

9.2.6 Adjust the value for each APA in column 6 to a whole number and enter in column 7 . .

Column 7

(9.2.6)

9.2.7 Sum the values in column 7 and enter in the Col. Sum row . . . .

Column 7

(9.2.7)

Compare (9.2.7) with the Sum Check value in column 7 (equal to (9.1.1). If the values agree, continue with Step 9.2.8.

9.2.8 Constrained reallocation for each APA, add: Col. 1. (9.1.3) + Col. 7. (9.2.6) and enter in column 8 . . . . . .

Column 8

(9.2.8)

9.2.9	Sum the values in column 8 and enter in the Col. Sum row	Column 8 (9.2.9)

Compare (9.2.9) with the Sum Check value in column 8 (equal to (9.1.1) + (9.1.2)). If the values agree, Worksheet 9 is completed.

Table 4 - 1

Worksheet for the Allocation of Patrol Personnel Among Several APAs Based on PAM Staff Estimates

Total Number of Additional (or Reduced) Personnel for All APAs (9.1.1) . . . . . [ ] **(TA)**

APA	Current Staff (9.1.3) Col. 1	PAM Staff Est. (9.1.5) Col. 2	**Unconst Reallo.** (9.1.7) Col. 3	Diff. Col. 1 -Col. 3 (9.2.1) Col. 4	(9.2.3.1) or (9.2.4.1) Col. 5	To Be Added (9.2.3.3) or Reduced (9.2.4.3) Col. 6	Rounded (9.2.6) Col. 7	**Constr. Reallo.** Col. 1 +Col. 7 (9.2.8) Col. 8
1								
2								
3								
4								
5								
6								
Col. Sum	(9.1.4) **(TC)**	(9.1.6) **(TE)**	(9.1.8)	(9.2.2)	(9.2.3.2) or (9.2.4.2) **(TN)**	(9.2.5)	(9.2.7)	(9.2.9)
Sum Check	(9.1.2) **(TC)**		(9.1.1) + (9.1.2) **(TA+TC)**	-1 x (9.1.1) **(-TA)**		(9.1.1) **(TA)**	(9.1.1) **(TA)**	(9.1.1) + (9.1.2) **(TA+TC)**

APPENDIX A: Supplemental Worksheet for Worksheet 5, Section 5.2

Instructions for Supplemental Worksheet: Uncommitted Patrol Availability - Immediate Response

The supplemental worksheet for Section 5.2 can be used to determine the number of patrol deputies (N_p) that will be required to insure that the probability that at least one deputy will be available for immediate response to an accident, CFS, or self-initiated activity meets or exceeds the user-specified performance requirement.

The number of patrol deputies (N_p) is based on the number of on-duty deputies required for reactive activities (N_r) determined in Worksheet 3, the average number of administrative minutes per hour per deputy (m_a) determined in Worksheet 2, the average number of minutes per hour per deputy spent on self-initiated activities (m_s) determined in Worksheet 4, and the estimated staffing distribution by time of day (i.e., by shift). The number of patrol deputies is determined using a queuing model that assumes randomly occurring accidents, CFS, and self-initiated activities with exponentially-distributed service times.

The procedure for determining N_p in Section 5.2 in Worksheet 5 relies on the following assumptions:

- the agency has uniform staffing on all shifts,
- the values for m_a and m_s are approximately equal to 15 and 9 minutes per hour per deputy respectively, and
- the same user-specified immediate response performance requirement applies to each shift.

These assumptions, valid for a wide range of agencies and operations, simplify the determination of N_p (Table 3-1 can be used to determine N_p for every shift).

If any of the assumptions cited above are not valid or applicable, the supplement worksheet presented below can be used in place of Section 5.2. The supplement worksheet determines the number of patrol deputies per day by estimating the number required for each shift and adding the results together. The number of patrol deputies required for each shift (N_{p1}, N_{p2}, and

N_{p3}) is determined with a table look-up based on the estimated number of on-duty deputies required for reactive activities on each shift (N_{r1}, N_{r2}, and N_{r3}). The appropriate table to be used is based on the values for m_a and m_s determined in worksheets 2 and 4 respectively.

The derivations of the formulas and procedures used in Section 5.2 and in the supplemental worksheet are presented in Section D.3 in Appendix D in the Guide.

Instructions for Individual Steps

A.2 Staffing Level By Shift

The values entered for (A.2.1), (A.2.2), and (A.2.3) represent the user's estimate of the percentage of staff that will be on duty on each shift for the APA. The sum of the percents over all shifts must equal 100. (Section 5.2 assumes the same percent for each shift.)

A.5 Determine Appropriate Table

A.5.1 K_s values are always positive and usually fall in the range of 0.15 to 0.35. Higher K_s values produce larger N_p values.

A.6 Number of Patrol Deputies Required for Each Shift

A.6.1 Number of Patrol Deputies Required for Shift 1

A.6.1.1 The supplemental worksheet permits the user to select, if desired, a different immediate response performance objective percentage for each shift. (Section 5.2 uses the same performance objective value for all shifts.)

A.6.1.2 The expected number of daily on-duty deputies for reactive activities for shift 1 (N_{r1}) is based on the user-specified staffing percent for shift 1 recorded in (A.2.1).

A.6.1.3 The table look-up process consists of the following steps:

- Locate the table identified in Step A.5.2.
- Examine the left-hand column of the table and select the row that is closest to the average daily number of reactive deputies for shift 1 (A.6.1.2).

- Read across the row until the percentage at the top of the column equals or exceeds the performance objective percent for shift 1 (A.6.1.1).

- The table entry indicates the average number of patrol deputies that are needed on shift 1 to meet the performance objective. Enter the table value in (A.6.1.3).

A.6.2 Number of Patrol Deputies Required for Shift 2

Read A.6.1.1, A.6.1.2, and A.6.1.3 above.

A.6.3 Number of Patrol Deputies Required for Shift 3

Read A.6.1.1, A.6.1.2, and A.6.1.3 above.

SUPPLEMENTAL WORKSHEET: Uncommitted Patrol Availability - Immediate Response

Objective: Determine the number of deputies required within the APA to provide an immediate response to a user-specified percent of all accidents, CFS, and self-initiated activities.

Method: A queuing model formulation for each shift based on randomly-occurring accidents, CFS, and self-initiated activities with exponentially-distributed service times. Input data includes the number of on-duty deputies required per day for reactive activities, the estimated staffing by shift, the average number of minutes per hour per deputy spent on administrative and self-initiated activities, and user-specified performance objectives for each shift.

A.1 Average daily number of on-duty deputies for reactive activities, use (3.3.3) . . . . . [ ] (N_r)
(A.1)

A.2 Staffing level by shift

A.2.1 Estimated percent of on-duty staff on shift 1, (a number between 0 and 100) . . . . . [ ]
(A.2.1)

A.2.2 Estimated percent of on-duty staff on shift 2, (a number between 0 and 100) . . . . . [ ]
(A.2.2)

A.2.3 Estimated percent of on-duty staff on shift 3, (a number between 0 and 100) . . . . . [ ]
(A.2.3)

NOTE: The sum of the percents for (A.2.1), (A.2.2), and (A.2.3) must equal 100.

A.3 Administrative time - minutes per hour per deputy (m_a), use (2.3) . . . . [ ] (m_a)
(A.3)

A.4 Self-initiated time - minutes per hour per deputy (m_s), use (4.4) . . . . [ ] (m_s)
(A.4)

A.5 Determine appropriate table

A.5.1 Determine adjustment factor based on m_a and m_s, use formula below . . . . . [ ] (K_s)
(A.5.1)

$$\underset{(A.5.1)}{K_s} = \frac{\text{Self-Initiated Time } (m_s)\ (A.4)}{60 - \text{Administrative Time } (m_a)\ (A.3) - \text{Self-Initiated Time } (m_s)\ (A.4)}$$

A.5.2 Select table based on K_s (A.5.1) from chart below . . . . [Table -]
(A.5.2)

If K_s (A.5.1) is in the range	Use Table (A.5.2)
0 - .099	A-1
.1 - .199	A-2
.2 - .249	3-1
.25 - .299	A-3
.3 - .399	A-4
.4 - .499	A-5
.5 - .599	A-6
.6 - .699	A-7
.7 - .799	A-8
.8 - .899	A-9
.9 or larger	A-10

A.6 Number of patrol deputies required for each shift

A.6.1 Number of patrol deputies required for shift 1

A.6.1.1 Performance objective, percent of accidents and CFS, immediate response (a number between 50 and and 99) . . . . . [ ] (A.6.1.1)

A.6.1.2 Expected number of daily on-duty deputies for reactive activities on shift 1, use formula below . . . . . [ ] (A.6.1.2) (N_{r1})

$$\text{Expected Number of On-Duty Deputies Per Per Day for Reactive Activities on Shift 1, } (N_{r1})\ (A.6.1.2) = \frac{\text{Percent of Staff on Shift 1 (A.2.1)} \times \text{Total Number of On-Duty Deputies Per Day } (N_r)\ (A.1)}{100}$$

A.6.1.3 Number of deputies required for shift 1, use (A.6.1.1), (A.6.1.2), and the table specified in (A.5.2) . . . . . [ ] (N_{p1})
(A.6.1.3)

A.6.2 Number of patrol deputies required for shift 2

A.6.2.1 Performance objective, percent of accidents and CFS, immediate response (a number between 50 and and 99) . . . . . [ ]
(A.6.2.1)

A.6.2.2 Expected number of daily on-duty deputies for reactive activities on shift 2, use formula below . . . . . [ ] (N_{r2})
(A.6.2.2)

$$\text{Expected Number of On-Duty Deputies Per Per Day for Reactive Activities on Shift 2, } (N_{r2})\ (A.6.2.2) = \frac{\text{Percent of Staff on Shift 2 (A.2.2)} \times \text{Total Number of On-Duty Deputies Per Day } (N_r)\ (A.1)}{100}$$

A.6.2.3 Number of deputies required for shift 2, use (A.6.2.1), (A.6.2.2), and the table specified in (A.5.2) . . . . . [ ] (N_{p2})
(A.6.2.3)

A.6.3 Number of patrol deputies required for shift 3

A.6.3.1 Performance objective, percent of accidents and CFS, immediate response (a number between 50 and and 99) . . . . . [ ] (A.6.3.1)

A.6.3.2 Expected number of daily on-duty deputies for reactive activities on shift 3, use formula below . . . . . [ ] (A.6.3.2) (N_{r3})

$$\text{Expected Number of On-Duty Deputies Per Per Day for Reactive Activities on Shift 3, } (N_{r3})\ (A.6.3.2) = \frac{\text{Percent of Staff on Shift 3 (A.2.3)} \times \text{Total Number of On-Duty Deputies Per Day } (N_r)\ (A.1)}{100}$$

A.6.3.3 Number of deputies required for shift 3, use (A.6.3.1), (A.6.3.2), and the table specified in (A.5.2) . . . . . [ ] (A.6.3.3) (N_{p3})

A.7 Total number of patrol deputies required per day within the APA to provide immediate response at the performance objective percents for each shift, add (A.6.1.3) + (A.6.2.3) + (A.6.3.3) . . . . . [ ] (A.7)

Enter (A.7) in (5.2.8) in Worksheet 5 and continue with Section 5.4.

Table A-1

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 0.10)

Number of Reactive Deputies (N_{ri}) (A.6.x.2)	Performance Objective Immediate Response Percentage (A.6.x.1)										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.4	1.7	1.9	2.3
.10	0.2	0.3	0.5	0.6	0.8	0.9	1.2	1.5	1.8	2.0	2.4
.15	0.2	0.4	0.6	0.7	0.9	1.0	1.2	1.6	1.9	2.2	2.6
.20	0.3	0.4	0.7	0.8	0.9	1.1	1.3	1.7	2.0	2.3	2.7
.25	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.8	2.1	2.4	2.8
.30	0.4	0.6	0.8	0.9	1.0	1.2	1.5	1.9	2.2	2.5	2.9
.40	0.5	0.7	0.9	1.0	1.1	1.3	1.6	2.1	2.4	2.7	3.1
.50	0.5	0.7	0.9	1.0	1.2	1.4	1.7	2.2	2.5	2.8	3.3
.60	0.6	0.7	1.0	1.1	1.3	1.5	1.8	2.3	2.7	3.0	3.4
.80	0.6	0.8	1.1	1.2	1.4	1.7	2.0	2.5	2.9	3.2	3.7
1.00	0.6	0.9	1.2	1.3	1.5	1.8	2.1	2.7	3.1	3.5	4.0
1.20	0.7	1.0	1.3	1.4	1.6	1.9	2.3	2.9	3.3	3.7	4.2
1.60	0.8	1.1	1.4	1.6	1.8	2.1	2.5	3.2	3.7	4.0	4.6
2.00	0.9	1.2	1.5	1.7	2.0	2.3	2.8	3.5	4.0	4.4	5.0
2.50	1.0	1.3	1.7	1.9	2.2	2.5	3.0	3.8	4.3	4.7	5.4
3.00	1.1	1.4	1.8	2.1	2.4	2.7	3.2	4.0	4.6	5.1	5.8
4.00	1.2	1.6	2.0	2.3	2.7	3.1	3.6	4.5	5.2	5.7	6.5
5.00	1.4	1.8	2.3	2.6	2.9	3.4	4.0	5.0	5.7	6.2	7.0

Table A-2

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 0.20)

Number of Reactive Deputies (N_{ri}) (A.6.x.2)	Performance Objective Immediate Response Percentage (A.6.x.1)										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.2	0.4	0.6	0.7	0.8	1.0	1.3	1.8	2.1	2.4	3.0
.10	0.3	0.4	0.6	0.8	0.9	1.1	1.4	1.9	2.3	2.6	3.1
.15	0.3	0.5	0.7	0.8	1.0	1.2	1.5	2.0	2.4	2.7	3.2
.20	0.3	0.5	0.8	0.9	1.1	1.3	1.6	2.1	2.5	2.8	3.3
.25	0.4	0.6	0.8	1.0	1.1	1.3	1.6	2.2	2.6	2.9	3.4
.30	0.5	0.6	0.9	1.0	1.2	1.4	1.7	2.2	2.6	3.0	3.5
.40	0.5	0.7	0.9	1.1	1.3	1.5	1.8	2.4	2.8	3.1	3.7
.50	0.6	0.8	1.0	1.2	1.3	1.6	1.9	2.5	2.9	3.3	3.9
.60	0.6	0.8	1.1	1.2	1.4	1.7	2.0	2.6	3.1	3.4	4.0
.80	0.7	0.9	1.2	1.3	1.5	1.8	2.2	2.8	3.3	3.7	4.3
1.00	0.7	1.0	1.3	1.4	1.7	2.0	2.4	3.0	3.5	3.9	4.5
1.20	0.8	1.0	1.3	1.5	1.8	2.1	2.5	3.2	3.7	4.1	4.8
1.60	0.9	1.2	1.5	1.7	2.0	2.3	2.8	3.5	4.1	4.5	5.2
2.00	1.0	1.3	1.6	1.9	2.1	2.5	3.0	3.8	4.4	4.8	5.6
2.50	1.1	1.4	1.8	2.0	2.3	2.7	3.2	4.1	4.7	5.2	6.0
3.00	1.1	1.5	1.9	2.2	2.5	2.9	3.5	4.4	5.0	5.5	6.4
4.00	1.3	1.7	2.2	2.5	2.8	3.3	3.9	4.9	5.6	6.1	7.1
5.00	1.4	1.8	2.4	2.7	3.1	3.6	4.3	5.3	6.1	6.7	7.7

Table A-3

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 0.30)

Number of Reactive Deputies (N_{ri}) (A.6.x.2)	Performance Objective Immediate Response Percentage (A.6.x.1)										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.3	0.4	0.7	0.8	1.0	1.2	1.5	2.1	2.6	3.0	3.6
.10	0.3	0.5	0.7	0.9	1.1	1.3	1.6	2.2	2.7	3.1	3.7
.15	0.4	0.6	0.8	0.9	1.1	1.4	1.7	2.3	2.8	3.2	3.8
.20	0.4	0.6	0.9	1.0	1.2	1.4	1.8	2.4	2.9	3.3	3.9
.25	0.5	0.7	0.9	1.0	1.2	1.5	1.8	2.5	3.0	3.4	4.0
.30	0.5	0.7	0.9	1.1	1.3	1.5	1.9	2.6	3.0	3.4	4.1
.40	0.6	0.8	1.0	1.2	1.4	1.6	2.0	2.7	3.2	3.6	4.3
.50	0.6	0.8	1.1	1.2	1.5	1.7	2.1	2.8	3.3	3.7	4.4
.60	0.6	0.9	1.1	1.3	1.5	1.8	2.2	2.9	3.5	3.9	4.6
.80	0.7	0.9	1.2	1.4	1.7	2.0	2.4	3.1	3.7	4.1	4.9
1.00	0.8	1.0	1.3	1.5	1.8	2.1	2.6	3.3	3.9	4.3	5.1
1.20	0.8	1.1	1.4	1.6	1.9	2.2	2.7	3.5	4.1	4.6	5.3
1.60	0.9	1.2	1.6	1.8	2.1	2.5	3.0	3.8	4.4	4.9	5.8
2.00	1.0	1.3	1.7	2.0	2.3	2.7	3.2	4.1	4.8	5.3	6.1
2.50	1.1	1.5	1.9	2.2	2.5	2.9	3.5	4.4	5.1	5.7	6.6
3.00	1.2	1.6	2.0	2.3	2.7	3.1	3.7	4.7	5.4	6.0	7.0
4.00	1.3	1.8	2.3	2.6	3.0	3.5	4.1	5.2	6.0	6.6	7.6
5.00	1.5	1.9	2.5	2.9	3.3	3.8	4.5	5.7	6.5	7.2	8.3

Table A-4

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 0.40)

Number of Reactive Deputies (N_{ri}) (A.6.x.2)	------- Performance Objective Immediate Response Percentage (A.6.x.1) --------										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.3	0.5	0.8	0.9	1.1	1.4	1.8	2.5	3.0	3.5	4.3
.10	0.4	0.6	0.8	1.0	1.2	1.4	1.8	2.6	3.1	3.6	4.4
.15	0.4	0.6	0.9	1.0	1.2	1.5	1.9	2.6	3.2	3.7	4.5
.20	0.5	0.7	0.9	1.1	1.3	1.6	2.0	2.7	3.3	3.7	4.5
.25	0.5	0.7	1.0	1.1	1.4	1.6	2.1	2.8	3.4	3.8	4.6
.30	0.6	0.7	1.0	1.2	1.4	1.7	2.1	2.9	3.4	3.9	4.7
.40	0.6	0.8	1.1	1.3	1.5	1.8	2.2	3.0	3.6	4.1	4.9
.50	0.6	0.9	1.2	1.3	1.6	1.9	2.3	3.1	3.7	4.2	5.0
.60	0.7	0.9	1.2	1.4	1.7	2.0	2.4	3.2	3.8	4.3	5.2
.80	0.8	1.0	1.3	1.5	1.8	2.1	2.6	3.5	4.1	4.6	5.4
1.00	0.8	1.1	1.4	1.6	1.9	2.3	2.8	3.6	4.3	4.8	5.7
1.20	0.9	1.2	1.5	1.8	2.0	2.4	2.9	3.8	4.5	5.0	5.9
1.60	1.0	1.3	1.7	1.9	2.2	2.6	3.2	4.1	4.8	5.4	6.3
2.00	1.1	1.4	1.8	2.1	2.4	2.8	3.4	4.4	5.2	5.7	6.7
2.50	1.2	1.5	2.0	2.3	2.6	3.1	3.7	4.8	5.5	6.1	7.1
3.00	1.2	1.6	2.1	2.4	2.8	3.3	4.0	5.1	5.9	6.5	7.5
4.00	1.4	1.8	2.4	2.7	3.1	3.7	4.4	5.6	6.4	7.1	8.2
5.00	1.5	2.0	2.6	3.0	3.4	4.0	4.8	6.1	7.0	7.7	8.9

Table A-5

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 0.50)

Number of Reactive Deputies (N_{ri}) (A.6.x.2)	Performance Objective Immediate Response Percentage (A.6.x.1)										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.4	0.6	0.8	1.0	1.2	1.5	2.0	2.8	3.4	4.0	4.9
.10	0.4	0.6	0.9	1.1	1.3	1.6	2.1	2.9	3.5	4.1	5.0
.15	0.5	0.7	1.0	1.1	1.4	1.7	2.1	3.0	3.6	4.1	5.1
.20	0.5	0.7	1.0	1.2	1.4	1.7	2.2	3.0	3.7	4.2	5.1
.25	0.6	0.8	1.0	1.2	1.5	1.8	2.3	3.1	3.8	4.3	5.2
.30	0.6	0.8	1.1	1.3	1.5	1.8	2.3	3.2	3.8	4.4	5.3
.40	0.6	0.9	1.2	1.4	1.6	2.0	2.4	3.3	4.0	4.5	5.5
.50	0.7	0.9	1.2	1.4	1.7	2.0	2.5	3.4	4.1	4.7	5.6
.60	0.7	1.0	1.3	1.5	1.8	2.1	2.6	3.5	4.2	4.8	5.7
.80	0.8	1.1	1.4	1.6	1.9	2.3	2.8	3.8	4.5	5.0	6.0
1.00	0.9	1.1	1.5	1.8	2.0	2.4	3.0	4.0	4.7	5.2	6.2
1.20	0.9	1.2	1.6	1.9	2.2	2.6	3.1	4.1	4.9	5.5	6.5
1.60	1.0	1.3	1.8	2.0	2.4	2.8	3.4	4.5	5.2	5.8	6.9
2.00	1.1	1.5	1.9	2.2	2.6	3.0	3.7	4.7	5.5	6.2	7.3
2.50	1.2	1.6	2.1	2.4	2.8	3.3	3.9	5.1	5.9	6.6	7.7
3.00	1.3	1.7	2.2	2.6	3.0	3.5	4.2	5.4	6.3	6.9	8.1
4.00	1.5	1.9	2.5	2.9	3.3	3.9	4.6	5.9	6.9	7.6	8.8
5.00	1.6	2.1	2.7	3.1	3.6	4.2	5.0	6.4	7.4	8.2	9.5

Table A-6

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 0.60)

Number of Reactive Deputies (N_{ri}) (A.6.x.2)	------- Performance Objective Immediate Response Percentage (A.6.x.1) --------										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.4	0.6	0.9	1.1	1.4	1.7	2.2	3.1	3.9	4.4	5.5
.10	0.5	0.7	1.0	1.2	1.4	1.8	2.3	3.2	3.9	4.5	5.6
.15	0.5	0.7	1.0	1.2	1.5	1.8	2.3	3.3	4.0	4.6	5.7
.20	0.6	0.8	1.1	1.3	1.5	1.9	2.4	3.4	4.1	4.7	5.7
.25	0.6	0.8	1.1	1.3	1.6	2.0	2.5	3.4	4.2	4.8	5.8
.30	0.6	0.8	1.2	1.4	1.6	2.0	2.5	3.5	4.2	4.8	5.9
.40	0.7	0.9	1.2	1.5	1.7	2.1	2.6	3.6	4.4	5.0	6.0
.50	0.7	1.0	1.3	1.5	1.8	2.2	2.8	3.7	4.5	5.1	6.2
.60	0.7	1.0	1.4	1.6	1.9	2.3	2.9	3.9	4.6	5.2	6.3
.80	0.8	1.1	1.5	1.7	2.0	2.4	3.0	4.1	4.8	5.5	6.6
1.00	0.9	1.2	1.6	1.9	2.2	2.6	3.2	4.3	5.1	5.7	6.8
1.20	0.9	1.3	1.7	2.0	2.3	2.7	3.4	4.4	5.3	5.9	7.0
1.60	1.1	1.4	1.9	2.1	2.5	3.0	3.6	4.8	5.6	6.3	7.4
2.00	1.1	1.5	2.0	2.3	2.7	3.2	3.9	5.1	5.9	6.6	7.8
2.50	1.3	1.7	2.2	2.5	2.9	3.4	4.2	5.4	6.3	7.0	8.3
3.00	1.3	1.8	2.3	2.7	3.1	3.7	4.4	5.7	6.7	7.4	8.7
4.00	1.5	2.0	2.6	3.0	3.5	4.1	4.9	6.3	7.3	8.1	9.4
5.00	1.7	2.2	2.9	3.3	3.8	4.4	5.3	6.8	7.8	8.7	10.1

Table A-7

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 0.70)

Number of Reactive Deputies (N_{ri}) (A.6.x.2)	Performance Objective Immediate Response Percentage (A.6.x.1)										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.4	0.7	1.0	1.2	1.5	1.9	2.4	3.5	4.3	4.9	6.1
.10	0.5	0.7	1.0	1.3	1.5	1.9	2.5	3.5	4.3	5.0	6.2
.15	0.6	0.8	1.1	1.3	1.6	2.0	2.6	3.6	4.4	5.1	6.2
.20	0.6	0.8	1.1	1.4	1.7	2.0	2.6	3.7	4.5	5.2	6.3
.25	0.6	0.9	1.2	1.4	1.7	2.1	2.7	3.7	4.6	5.2	6.4
.30	0.6	0.9	1.2	1.5	1.8	2.2	2.7	3.8	4.6	5.3	6.5
.40	0.7	1.0	1.3	1.6	1.9	2.3	2.9	3.9	4.8	5.4	6.6
.50	0.7	1.0	1.4	1.6	1.9	2.4	3.0	4.0	4.9	5.6	6.7
.60	0.8	1.1	1.4	1.7	2.0	2.4	3.1	4.2	5.0	5.7	6.9
.80	0.9	1.2	1.6	1.8	2.2	2.6	3.2	4.4	5.2	5.9	7.1
1.00	0.9	1.2	1.7	1.9	2.3	2.7	3.4	4.6	5.4	6.1	7.4
1.20	1.0	1.3	1.8	2.1	2.4	2.9	3.6	4.7	5.6	6.4	7.6
1.60	1.1	1.5	1.9	2.3	2.6	3.1	3.8	5.1	6.0	6.7	8.0
2.00	1.2	1.6	2.1	2.4	2.8	3.4	4.1	5.4	6.3	7.1	8.4
2.50	1.3	1.7	2.3	2.6	3.1	3.6	4.4	5.7	6.7	7.5	8.8
3.00	1.4	1.9	2.4	2.8	3.3	3.8	4.6	6.0	7.1	7.9	9.2
4.00	1.6	2.1	2.7	3.1	3.6	4.2	5.1	6.6	7.7	8.5	10.0
5.00	1.7	2.3	3.0	3.4	3.9	4.6	5.5	7.1	8.3	9.1	10.7

Table A-8

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 0.80)

Number of Reactive Deputies (N_{ri}) (A.6.x.2)	------- Performance Objective Immediate Response Percentage (A.6.x.1) --------										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.5	0.7	1.1	1.3	1.6	2.0	2.6	3.8	4.7	5.4	6.7
.10	0.5	0.8	1.1	1.4	1.7	2.1	2.7	3.8	4.7	5.5	6.8
.15	0.6	0.8	1.2	1.4	1.7	2.1	2.8	3.9	4.8	5.5	6.8
.20	0.6	0.9	1.2	1.5	1.8	2.2	2.8	4.0	4.9	5.6	6.9
.25	0.6	0.9	1.3	1.5	1.8	2.3	2.9	4.1	5.0	5.7	7.0
.30	0.7	0.9	1.3	1.6	1.9	2.3	2.9	4.1	5.0	5.8	7.0
.40	0.7	1.0	1.4	1.6	2.0	2.4	3.1	4.2	5.1	5.9	7.2
.50	0.8	1.1	1.5	1.7	2.1	2.5	3.2	4.4	5.3	6.0	7.3
.60	0.8	1.1	1.5	1.8	2.1	2.6	3.3	4.5	5.4	6.1	7.4
.80	0.9	1.2	1.6	1.9	2.3	2.8	3.4	4.7	5.6	6.4	7.7
1.00	1.0	1.3	1.7	2.0	2.4	2.9	3.6	4.9	5.8	6.6	7.9
1.20	1.0	1.4	1.8	2.2	2.5	3.0	3.8	5.1	6.0	6.8	8.2
1.60	1.1	1.5	2.0	2.4	2.8	3.3	4.1	5.4	6.4	7.2	8.6
2.00	1.2	1.6	2.2	2.5	3.0	3.5	4.3	5.7	6.7	7.5	8.9
2.50	1.3	1.8	2.4	2.7	3.2	3.8	4.6	6.0	7.1	7.9	9.4
3.00	1.4	1.9	2.5	2.9	3.4	4.0	4.9	6.4	7.5	8.3	9.8
4.00	1.6	2.1	2.8	3.2	3.8	4.4	5.4	6.9	8.1	9.0	10.6
5.00	1.8	2.4	3.1	3.5	4.1	4.8	5.8	7.5	8.7	9.6	11.2

Table A-9

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 0.90)

Number of Reactive Deputies (N_{ri}) (A.6.x.2)	Performance Objective Immediate Response Percentage (A.6.x.1)										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.5	0.8	1.1	1.4	1.7	2.2	2.8	4.1	5.1	5.9	7.3
.10	0.6	0.8	1.2	1.4	1.8	2.2	2.9	4.2	5.1	5.9	7.3
.15	0.6	0.9	1.2	1.5	1.8	2.3	3.0	4.2	5.2	6.0	7.4
.20	0.6	0.9	1.3	1.6	1.9	2.4	3.0	4.3	5.3	6.1	7.5
.25	0.7	0.9	1.3	1.6	1.9	2.4	3.1	4.4	5.3	6.1	7.6
.30	0.7	1.0	1.4	1.6	2.0	2.5	3.2	4.4	5.4	6.2	7.6
.40	0.8	1.0	1.5	1.7	2.1	2.6	3.3	4.5	5.5	6.3	7.8
.50	0.8	1.1	1.5	1.8	2.2	2.7	3.4	4.7	5.7	6.5	7.9
.60	0.8	1.2	1.6	1.9	2.3	2.7	3.5	4.8	5.8	6.6	8.0
.80	0.9	1.3	1.7	2.0	2.4	2.9	3.7	5.0	6.0	6.8	8.3
1.00	1.0	1.4	1.8	2.1	2.5	3.1	3.8	5.2	6.2	7.0	8.5
1.20	1.1	1.4	1.9	2.3	2.7	3.2	4.0	5.4	6.4	7.2	8.7
1.60	1.2	1.6	2.1	2.5	2.9	3.5	4.3	5.7	6.8	7.6	9.1
2.00	1.3	1.7	2.3	2.6	3.1	3.7	4.5	6.0	7.1	8.0	9.5
2.50	1.4	1.9	2.5	2.8	3.3	3.9	4.8	6.4	7.5	8.4	10.0
3.00	1.5	2.0	2.6	3.0	3.5	4.2	5.1	6.7	7.9	8.8	10.4
4.00	1.7	2.2	2.9	3.4	3.9	4.6	5.6	7.3	8.5	9.5	11.1
5.00	1.8	2.4	3.2	3.7	4.2	5.0	6.0	7.8	9.1	10.1	11.8

Table A-10

Number of Patrol Deputies Required To Provide Immediate Response Capability Based On the Average Number of Reactive Deputies Required and the Selected Response Percentage (K_s = 1.00)

Number of Reactive Deputies (N_{ri}) (A.6.x.2)	Performance Objective Immediate Response Percentage (A.6.x.1)										
	50	60	70	75	80	85	90	95	97	98	99
.05	0.6	0.8	1.2	1.5	1.8	2.3	3.1	4.4	5.5	6.3	7.8
.10	0.6	0.9	1.3	1.5	1.9	2.4	3.1	4.5	5.5	6.4	7.9
.15	0.6	0.9	1.3	1.6	2.0	2.4	3.2	4.5	5.6	6.5	8.0
.20	0.7	1.0	1.4	1.6	2.0	2.5	3.2	4.6	5.7	6.5	8.1
.25	0.7	1.0	1.4	1.7	2.1	2.6	3.3	4.7	5.7	6.6	8.1
.30	0.7	1.0	1.5	1.7	2.1	2.6	3.4	4.7	5.8	6.7	8.2
.40	0.8	1.1	1.5	1.8	2.2	2.7	3.5	4.9	5.9	6.8	8.3
.50	0.8	1.2	1.6	1.9	2.3	2.8	3.6	5.0	6.0	6.9	8.5
.60	0.9	1.2	1.7	2.0	2.4	2.9	3.7	5.1	6.2	7.0	8.6
.80	1.0	1.3	1.8	2.1	2.5	3.1	3.9	5.3	6.4	7.3	8.8
1.00	1.0	1.4	1.9	2.2	2.7	3.2	4.0	5.5	6.6	7.5	9.1
1.20	1.1	1.5	2.0	2.4	2.8	3.4	4.2	5.7	6.8	7.7	9.3
1.60	1.2	1.6	2.2	2.6	3.0	3.6	4.5	6.0	7.2	8.1	9.7
2.00	1.3	1.8	2.4	2.7	3.2	3.8	4.7	6.3	7.5	8.4	10.1
2.50	1.4	1.9	2.5	3.0	3.5	4.1	5.0	6.7	7.9	8.9	10.5
3.00	1.5	2.1	2.7	3.1	3.7	4.4	5.3	7.0	8.2	9.2	10.9
4.00	1.7	2.3	3.0	3.5	4.1	4.8	5.8	7.6	8.9	9.9	11.7
5.00	1.9	2.5	3.3	3.8	4.4	5.2	6.3	8.1	9.5	10.6	12.4

APPENDIX B: Supplemental Worksheet for Worksheet 5, Step 5.3.7

Instructions for Supplemental Worksheet: Uncommitted Patrol Availability - Line Patrol

The supplemental worksheet for Step 5.3.7 is used to determine the number of patrol deputies in the APA during the hours of coverage for line patrol (i.e., uncommitted patrol activities restricted to a roadway segment.) The criterion for determining how many deputies are needed is the average travel time to reactive activities.

This step should only be used when some deputies are assigned to specific roadway segments with no responsibilities other than police services on the roadway. If line patrols are used, the number of deputies required Step (5.3.7) is added to the number of deputies required for area patrol Step (5.3.6) to obtain the total number of deputies to meet the user-specified average travel time performance objective.

The formula for the number of deputies required for line patrol (Step B.6) is based on the:

- shift length (hours),
- patrol coverage per week (hours),
- number of roadway miles,
- coverage per week (hours),
- average response speed (MPH), and
- average travel time specified by the agency.

The derivation of the formula for travel time for line patrol is presented in Section D.5 in Appendix D in the Guide.

Instructions for Individual Steps

B.3 Roadway Miles to be Patrolled (Miles) (D)

The total number of highway miles for line patrol depends on the access between opposite direction lanes. If complete access is available, the number of highway miles to be

patrolled will equal the length of the segment. If, however, no access is available between the opposing direction lanes except at each end of the segment and at a limited number of crossover points, the "effective" number of highway miles to be patrolled will be greater than the length of the segment. The chart below can be used to estimate the "effective" number of miles for line patrol that should be used for Step 5.4.3. To use the chart, find the row that best corresponds to the number and location of crossover points along the highway segment. The entry for Step (5.4.3) is obtained by multiplying the length of the highway segment in miles by the value listed in the righthand column (Adjustment Factor) of the row.

Number of Access Points	Location of Access Points	Adjustment Factor
2	Each end of the segment . . .	3.000
3	Each end of the segment and middle of the segment . . .	2.250
4	Each end of the segment and two crossovers dividing the segment into thirds . .	1.889
5	Each end of the segment and three crossovers dividing the segment into fourths .	1.689
6	Each end of the segment and four crossovers dividing the segment into fifths . .	1.560
Unlimited	Everywhere	1.000

B.4 Average Response Speed (MPH) (D)

The average speed of a patrol unit while responding to a CFS. The average speed is usually lower than anticipated due to factors that may delay or impede a responding unit (e.g., heavy traffic, cornering, etc.).

B.5 Averge Travel Time Performance Objective (Minutes) (P).

The user-specified average travel time performance objective for patrol unit response to accidents and other CFS within the APA. It is important to note that this procedure is based on the <u>average</u> travel time, not a maximum time. The number of deputies determined in Step (B.6) will provide a level of deputy availability on the roadway segment that will produce travel times that collectively will equal the travel time performance objective value. For individual responses, however, some travel times will be lower than the objective value and some will be higher. The number of deputies obtained in Step (B.6) does <u>not</u> guarantee that the travel time to every incident will be less than the performance objective value.

SUPPLEMENTAL WORKSHEET Uncommitted Patrol Availability - Line Patrol

Objective: Determine the number of deputies required within the APA on line patrol to provide an acceptable level of availability.

Method: Based on the average travel time to accidents and other CFS.

B.1 Shift length (hours), use (1.2.1) . . . . [ ] (B.1)

B.2 Coverage per week (hours), (maximum value = 168) . . . . . [ ] (B.2)

B.3 Total roadway miles to be patrolled within the APA . . . . . [ ] (B.3)

B.4 Average response speed (MPH) (equal to or greater than average patrol speed) . . . . . [ ] (B.4)

B.5 Average travel time performance objective (minutes) . . . . . [ ] (B.5)

B.6 Number of deputies required within the APA to meet the average time travel performance objective, use formula given below . . . . . .

(B.6)

$$\text{No. of On-Duty Deputies, Line Patrol (B.6)} = \frac{20 \times \text{Roadway Miles (B.3)} \times \text{Coverage Per Week (Hours) (B.2)}}{7 \times \text{Speed (MPH) (B.4)} \times \text{Time (min) (B.5)} \times \text{Shift Length (hours) (B.1)}}$$

Enter (B.6) into (5.3.7) in Worksheet 5.

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